

## SpeX Spectroscopy of Unresolved Very Low Mass Binaries. II. Identification of Fourteen Candidate Binaries with Late-M/Early-L and T Dwarf Components

Daniella C. Bardalez Gagliuffi<sup>1,11</sup>, Adam J. Burgasser<sup>1,11</sup>, Christopher R. Gelino<sup>2,12</sup>, Dagny L. Looper<sup>3,11</sup>, Christine P. Nicholls<sup>1,4</sup>, Sarah J. Schmidt<sup>5,11</sup>, Kelle Cruz<sup>6,7</sup>, Andrew A. West<sup>8</sup>, John E. Gizis<sup>9</sup>, Stanimir Metchev<sup>10</sup>.

### ABSTRACT

Multiplicity is a key statistic for understanding the formation of very low mass (VLM) stars and brown dwarfs. Currently, the separation distribution of VLM binaries remains poorly constrained at small separations ( $\leq 1$  AU), leading to uncertainty in the overall binary fraction. We approach this problem by searching for late-M/early-L plus T dwarf spectral binaries whose combined light spectra exhibit distinct peculiarities, allowing for separation-independent identification. We define a set of spectral indices designed to identify these systems, and use a spectral template fitting method to confirm and characterize spectral binary (SB) candidates from a library of 815 spectra from the SpeX Prism Spectral Libraries. We present eleven new binary candidates, confirm three previously reported candidates and rule out two previously identified candidates, all with primary and secondary spectral types between M7-L7 and T1-T8, respectively. We find that subdwarfs and blue L dwarfs are the primary contaminants in our sample and propose a method for segregating these sources. If confirmed by follow-up observations, these systems may add to the growing list of tight separation binaries, whose orbital properties may yield further insight into brown dwarf formation scenarios.

---

<sup>1</sup>Center for Astrophysics and Space Sciences, University of California, San Diego, 9500 Gilman Dr., Mail Code 0424, La Jolla, CA 92093, USA. [daniella@physics.ucsd.edu](mailto:daniella@physics.ucsd.edu)

<sup>2</sup>NASA Exoplanet Science Institute, Mail Code 100-22, California Institute of Technology, 770 South Wilson Ave, Pasadena, CA 91125, USA.

<sup>3</sup>Tisch School of the Arts, New York University, 721 Broadway, New York, NY 10003, USA.

<sup>4</sup>School of Mathematics and Physics, The University of Queensland, Brisbane, QLD 4072, Australia.

<sup>5</sup>Department of Astronomy, Ohio State University, 140 West 18th Ave., Columbus, OH 43210, USA.

<sup>6</sup>Department of Physics and Astronomy, Hunter College, City University of New York, 695 Park Avenue, New York, NY 10065, USA.

<sup>7</sup>Department of Astrophysics, American Museum of Natural History, Central Park West at 79th St., New York, NY 10024, USA.

<sup>8</sup>Department of Astronomy, Boston University, CAS 422A, 725 Commonwealth Ave., Boston, MA 02215, USA.

<sup>9</sup>Department of Physics and Astronomy, University of Delaware, 104 The Green, Newark, DE 19716, USA.

<sup>10</sup>Department of Physics and Astronomy, Western University, London, Ontario, Canada, N6A 3K7.

<sup>11</sup>Visiting Astronomer at the Infrared Telescope Facility, which is operated by the University of Hawaii under Cooperative Agreement no. NNX-08AE38A with the National Aeronautics and Space Administration, Science Mission Directorate, Planetary Astronomy Program.

<sup>12</sup>Infrared Processing and Analysis Center, Mail Code 100-22, California Institute of Technology, 1200 E California Blvd., Pasadena, CA 91125, USA.

*Subject headings:* stars: low-mass, stars:brown dwarfs, stars: binaries: close, stars: binaries: general.

## 1. Introduction

Brown dwarfs are self-gravitating objects with physical and atmospheric properties intermediate between stars and planets. With masses below  $\simeq 0.075 M_{\odot}$ <sup>1</sup> (Kumar 1963; Hayashi & Nakano 1963), these objects cannot sustain hydrogen fusion, and hence cool and dim as they age, radiating primarily at infrared wavelengths. The evolution of their spectra spans the spectral classes M, L, T, and Y, with transitions demarcated by the appearance and disappearance of absorption lines and bands as molecules form and condense out of their atmospheres at different temperatures and pressures (Kirkpatrick 2005 and references therein).

Despite having a basic understanding of their evolution, brown dwarf formation remains an open question. Standard Jeans collapse of molecular clouds requires high densities so that gravity can overcome thermal pressure. Once the collapse has begun, halting the accretion becomes problematic (Shu et al. 1987). Several mechanisms have been proposed to resolve this issue, including turbulent fragmentation of protostellar clouds (Padoan & Nordlund 2002), fragmentation of pre stellar disks (Stamatellos & Whitworth 2009), ejection by dynamical interactions with other protostars (Reipurth & Clarke 2001), and photoerosion of prestellar cores (Whitworth & Zinnecker 2004). In principle, these formation mechanisms should leave traces on the statistical properties of brown dwarfs, including the occurrence of multiple systems and distributions of their separation, relative masses and eccentricity.

Observationally, it has been shown that multiplicity increases with primary mass, even at the lower mass end of the main sequence, with the G dwarf binary fraction being 57% higher than that for M dwarfs (Fischer & Marcy 1992; Delgado-Donate et al. 2004). Current estimates of the binary fraction of very low mass (VLM) late-M to T dwarfs ( $VLM M_{\text{total}} < 0.1 M_{\odot}$ ) are 20 – 25%, with a peak in separation at  $\sim 4$  AU and a mass ratio distribution peaking at nearly equal masses (Bouy et al. 2003; Close et al. 2003; Burgasser et al. 2006b; Allen 2007; Kraus & Hillenbrand 2012). However, these multiplicity statistics have been largely determined from resolved imaging programs, sampling separations greater than 3 AU. Burgasser et al. (2007b) pointed out that the current peak in the binary angular separation distribution is coincident with the resolution limit of HST and ground-based adaptive optics (AO) imaging, indicating that tight ( $< 1$  AU) VLM binaries could be undercounted. Likewise, Pinfield et al. (2003) and Chappelle et al. (2005) report a higher unresolved binary fraction (30 – 50%) based on overluminous binary candidates in color-magnitude plots. Conversely, spectroscopic radial velocity (RV) studies find binary fractions of 2.5% in systems separated by  $< 1$  AU (Blake et al. 2010) and 2 – 28% up to 3 AU (Joergens 2008). For the 0-6 AU range, Basri & Reiners (2006) estimate a binary fraction of  $26\% \pm 10\%$ . However, the difficulty of obtaining high resolution spectra of faint VLM dwarfs results in small sample size. Since total binary fractions for VLM stars and brown dwarfs could range between 2 – 50%, it is imperative to constrain this statistic to make conclusions about brown dwarf formation.

An alternative method for detecting tight unresolved binaries, developed by Burgasser (2007a), involves identifying blended light pairs, or spectral binaries. We will refer as *spectral* binaries to those objects

---

<sup>1</sup>Minimum mass for Hydrogen fusion may vary between 0.072-0.078  $M_{\odot}$  depending on age and metallicity. See Burrows et al. (1997) for an extensive discussion of evolutionary models.

whose combined-light spectrum shows distinct peculiarities that come from the highly structured spectra of single M, L and T dwarfs when blended together, as opposed to *spectroscopic* binaries which are binaries that show RV variations. The first brown dwarf spectral binary, 2MASS J05185995–2828372, was serendipitously identified by Cruz et al. (2004) based on its hybrid characteristics containing features of both L and T dwarfs. The superposition of L plus T dwarf spectra proved to be the simplest model of its peculiar spectrum and it was later resolved as a binary using the Hubble Space Telescope (Burgasser et al. 2006b). The unusually blue L dwarf SDSS J080531.84+481233.0 was next identified as a spectral binary with L4.5 and T5 components by Burgasser (2007b), based on a peculiar methane absorption band starting at  $1.60\ \mu\text{m}$ , and was later confirmed as an astrometric variable by Dupuy & Liu (2012). A third system, 2MASS J03202839–0446358, was concurrently identified as an unresolved M9+T5 spectral binary (Burgasser et al. 2008a) and a RV variable with an orbital period of eight months (Blake et al. 2008). These examples serve to illustrate how spectral binaries can encompass a broad range of system architectures. To date, 34 VLM spectral binaries and candidates have been reported (see Table 1), and ten have been confirmed by direct imaging, RV or astrometric variability (Burgasser et al. 2011a; Stumpf et al. 2011; Burgasser et al. 2012; Dupuy & Liu 2012; Faherty et al. 2012; Manjavacas et al. 2013; Gelino et al. in prep).

Detecting binaries using the spectral binary method is particularly useful for multiplicity statistics, as the method is independent of separation within  $0''.5$ , which translates to  $<10\text{--}20$  AU for field brown dwarfs at distances of 20–40 pc. The closest separation pairs can be followed-up to measure orbits and component masses, as well as infer ages by comparison to evolutionary models (Burgasser & Blake 2009). Systems with independent age constraints can also be used to test the evolutionary models directly (Dupuy et al. 2009; Liu et al. 2010; Burgasser et al. 2011a). Additionally, unresolved binaries are strong contaminants in luminosity functions that later lead to uncertainties in mass functions and studies of formation history through stellar populations (Day-Jones et al. 2013), so their identification is extremely important. Finally, spectral binaries with late-M/early-L primaries and T dwarf secondaries can straddle the hydrogen burning limit, thus giving additional insight into brown dwarf evolution.

In this paper we adapt the technique of Burgasser et al. (2010a) to search for spectral binaries composed of late-M or early-L dwarf primaries with T dwarf secondaries. M dwarfs are the most common stars in the galaxy (Bochanski et al. 2010), and are the brightest VLM objects, enabling better statistics through larger magnitude-limited search volumes and sample sizes. M-dwarf spectra are also intrinsically distinct from T-dwarf spectra, but differ in brightness by several magnitudes, rendering peculiar features extremely subtle. In § 2 we describe our spectral sample used to find spectral binaries, drawn from the SpeX Prism Libraries and new observations. In § 3 we explain our two methods to identify spectral binary candidates: by visual examination (§ 3.1) and through spectral indices (§ 3.2). In § 3.3, we perform single and binary template fitting to identify fourteen binary candidates. In § 4, we describe the properties of the candidates. In § 5.1 and § 5.2, we discuss our major contaminant, blue L dwarfs, and show preliminary evidence that the separations of spectral binaries are tighter than the resolved population. Our results are summarized in § 6.

## 2. SpeX Spectral Sample

The SpeX Prism Library is composed of low resolution ( $\lambda/\Delta\lambda = 75 - 120$ ) spectra acquired with the SpeX  $0.8 - 2.5\ \mu\text{m}$  spectrograph, mounted on the 3.0 m NASA Infrared Telescope Facility (IRTF), located in Mauna Kea, Hawaii (Rayner et al. 2003). All spectra were obtained using the prism-dispersed SpeX mode, which continuously samples wavelengths between  $0.75 - 2.5\ \mu\text{m}$  at a dispersion of  $20 - 30\ \text{\AA pixel}^{-1}$ .

The library includes close to 2,000 sources, both previously published data<sup>2</sup> and 530 new spectra acquired between November 2000 and December 2013 (Table 2). The new observations were obtained with the 0".5 or 0".7 slit, generally aligned with the parallactic angle. Total integration times ranged between 360 s and 1200 s, depending on source brightness and atmospheric conditions, and were obtained in an ABBA dither pattern along the slit. Spectra of nearby A0 V stars were used to flux calibrate the raw spectra and correct for telluric absorption. Internal flat fields and argon arc lamps were observed with each flux standard for pixel response and wavelength calibration. All data were reduced with the SpeXtool package (Cushing et al. 2004; Vacca et al. 2003) using standard settings. A detailed description of our reduction procedures is given in Burgasser (2007b).

The sources observed have optical and/or near-infrared spectral classifications reported in the literature. To obtain a self-consistent set of spectral types, we computed SpeX spectral types based on spectral indices, following the method described in Burgasser (2007a). From these, we selected two samples: the “candidate” sample which has been purged of spectral types outside the M7-L7 range, optical subdwarfs, giants, and poor quality spectra, but keeping binaries, objects suspected of being binaries from previous studies, young objects and unusually red and blue dwarfs, and the “template” sample which has been purged of binaries, candidate binaries, giants and poor quality spectra (as determined by visual inspection) only. The “candidate” sample contains 815 spectra of 738 objects with SpeX spectral types between M7-L7, as those would be the potential primaries for late-M/early-L plus T binaries. The “template” sample comprise 1110 spectra of 992 single sources whose spectral types range between M7-L7 for primaries and T1-T8 for secondaries used in spectral fitting.

The distribution of spectral types for both samples is shown in Figure 1. In both samples, the number of spectra decreases toward later spectral types due to declining space densities for L dwarfs (Cruz et al. 2003) and sensitivity limits for late L and T dwarfs. Since there are significantly more sources with late-M spectral types in our samples, it is more likely to find binaries with a late-M primary. The sources included were observed as part of several different programs, including our ongoing program to compile a magnitude-limited sample of L dwarfs (Burgasser et al. in prep.). As such, we do not claim the sample to be complete or unbiased.

### 3. Identification of spectral binaries

#### 3.1. Visual inspection

The spectral morphology of unresolved late-M/early-L plus T dwarf binary systems gives rise to a distinctive feature in blended-light spectra: a small “dip” centered at  $1.63\ \mu\text{m}$ , which is the combination of  $\text{CH}_4$  absorption from the secondary and  $\text{FeH}$  from the primary (Cushing et al. 2003; Burgasser 2007b). Methane does not exist in the spectra of late-M/early-L dwarfs, so its presence indicates a T dwarf companion. However, this feature is very weak in blended-light spectra since a T dwarf is significantly fainter than the M/L primary (e.g.  $\Delta J \sim 3.5$  mag between an M8 and a T5, which is the case for 2MASS J03202839–0446358). Moreover, variations in the spectral slope for a blue or red L dwarf, can make this feature ambiguous, as can poor correction of Hydrogen lines in the A0V calibrators. Alternative indicators such as a relatively higher flux around the  $1.25\ \mu\text{m}$  peak and an inflated bump short ward of  $2.2\ \mu\text{m}$ , may also reveal the presence of a T dwarf companion, or that the spectrum of the source is unusually blue.

---

<sup>2</sup>e.g. Burgasser et al. (2010a); Chiu et al. (2006); Cruz et al. (2003).

To facilitate our visual inspection, we fit the candidate sample to templates of single objects, following the same chi-squared minimization routine as in Section 3.3, and then subtracted the median combination of the ten best fitting single sources from each spectrum. The objects with residuals consistent with a T dwarf spectrum were selected as visual candidates. To validate this procedure, we also performed the same template subtraction on four confirmed spectral binaries: SDSS J000649.16–085246.3, 2MASS J03202839–0446358, SDSS J080531.89+481233.0, and 2MASS J13153094–2649513 (see Table 1). The residuals from these subtractions clearly exhibited T dwarf-like morphologies. Twelve sources were selected as visual candidates.

### 3.2. Spectral indices

In addition to visual inspection, we also used spectral indices to identify additional candidate binaries due to the subtlety of T dwarf features in combined-light spectra (Burgasser et al. 2010a). We initially examined standard classification indices from Burgasser et al. (2006a), as well as the “ $H$ -dip” index from Burgasser et al. (2010a), and further defined five new indices. The new indices were designed by comparing the residuals of the four known binary spectra after subtracting their best single template fits. As a control sample, we also examined single templates subtracted from each other, which showed no evidence for a T dwarf companion.

The new spectral indices specifically designed in this paper are:

- $H$ -bump: measures the peak in the continuum from the T dwarf in the  $H$  band relative to the dip centered around  $1.63 \mu\text{m}$  seen in M+T binaries, making this index complimentary to  $H$ -dip. A higher value of  $H$ -bump implies a larger flux at  $1.55 \mu\text{m}$ , possibly caused by the presence of a T dwarf.
- $J$ -curve: designed to detect the flux coming from both the  $1.05 \mu\text{m}$  and  $1.27 \mu\text{m}$  peaks of a T dwarf, as compared to the deep methane absorption at  $1.12 \mu\text{m}$ .
- $J$ -slope and  $K_s$ -slope: measure the slope of the peaks in the  $J$  and  $K_s$  bands at  $1.27 \mu\text{m}$  and  $2.10 \mu\text{m}$ . In both cases, the peaks in a single late-M/early-L should look somewhat flat, giving values close to one, whereas in a late-M/early-L plus T dwarf binary the slope of the  $J$  and  $K_s$  band peaks are slightly negative and positive, respectively.
- $\text{H}_2\text{O}-Y$ : measures the prominence of the  $Y$ -band peak of the T dwarf at  $\sim 1.05 \mu\text{m}$  compared to the water and methane absorption around  $\sim 1.15 \mu\text{m}$ . M and L dwarfs do not present peaks in the  $Y$ -band.

The thirteen indices examined are described in Table 3. We also used  $J-K_s$ ,  $J-H$  and  $H-K_s$  colors synthesized from the spectra themselves, and the source spectral type, for a total of seventeen parameters.

Comparing all seventeen parameters against each other yielded 136 pairings. After visual examination to determine which pairings best segregated the four known M/L+T binaries, twelve combinations were selected (Figure 2). We then used two techniques to define regions of interest in each combination for candidate selection. If a trend among all sources was clear, we fit the points to a second order polynomial and defined a region demarcated in the y-axis by the  $+1\sigma$  or  $-1\sigma$  curves from the fit function, and in the x-axis by the horizontal spread of the binary benchmarks. Conversely, if the points did not indicate any trends, then the region was demarcated such that it included the four binary benchmarks. The limits to these regions are described in Table 4.

Objects falling in eight or more selection regions were considered strong index candidates, those falling in four to eight regions were considered weak index candidates (Figure 6). The number of selected sources rises steadily below four or five combinations, suggesting that sources selected fewer than four times could be spurious. Three of our benchmarks were selected by all twelve combinations, while SDSS J0006–0852 missed only the SpT/CH<sub>4</sub>-H cut, since it falls within one standard deviation from the fitting curve.

In total, eight strong and twenty-two weak candidates were selected, including the previously identified spectral binaries 2MASS J20261584–2943124 (Gelino & Burgasser 2010) and 2MASS J13114227+3629235 (Kirkpatrick et al. 2011). Seven visual candidates overlapped with the index candidates: five as strong and two as weak.

### 3.3. Spectral template fitting

To statistically test the binary hypothesis for our visual and index-selected candidates, we compared each spectrum to templates of both single sources and binary systems, using the method described in Burgasser et al. (2010a). The candidates determined by visual inspection or spectral index selection were first rejected from the template pool. Then, all spectra were interpolated onto a common wavelength scale from 0.8 to 2.4  $\mu\text{m}$  and normalized to the peak flux between 1.2 – 1.3  $\mu\text{m}$ . Each candidate spectrum  $C[\lambda]$  was directly compared to all single templates  $T[\lambda]$  and ranked by a weighted chi-squared statistic.

$$\chi^2 \equiv \sum_{\lambda} w[\lambda] \left[ \frac{C[\lambda] - \alpha T[\lambda]}{\sigma_c[\lambda]} \right]^2 \quad (1)$$

where  $w[\lambda]$  is a vector of weights proportional to the wave band size of each pixel (see Cushing et al. 2008),  $\alpha$  is a scaling factor minimizing  $\chi^2$  and  $\sigma_c[\lambda]$  is the noise spectrum for each candidate. The statistic was computed over the wavelength range:  $\{\lambda\} = 0.95 - 1.35 \mu\text{m}$ ,  $1.45 - 1.80 \mu\text{m}$  and  $2.00 - 2.35 \mu\text{m}$ , avoiding regions of strong telluric absorption.

Binary templates were constructed by first scaling each template spectrum to absolute fluxes using the 2MASS  $M_{K_s}$  versus spectral type relation of Looper et al. (2008a), and then combining all pairs of single templates, such that the spectral type of the primary was earlier than that of the secondary resulting in a total of 638,686 binary templates<sup>3</sup>. More specifically, the primary spectral type was fixed to lie between M7-L7 while the secondary spectral type ranged between T1-T8, since types earlier than T1 do not evidence strong methane features yet. The best binary fits were ranked using a chi-squared minimization routine. We determined the true significance that a binary template is superior to a single template by comparing the  $\chi^2$  distributions of the binary and single fits using the one-sided F-test statistic  $\eta_{\text{SB}}$ :

$$\eta_{\text{SB}} \equiv \frac{\min(\{\chi_{\text{single}}^2\}) \text{dof}_{\text{binary}}}{\min(\{\chi_{\text{binary}}^2\}) \text{dof}_{\text{single}}}. \quad (2)$$

Here, dof is the degrees of freedom for each fit (Equation 2 in Burgasser et al. (2010a)). Candidates with an F-statistic falling under the 90% confidence level were rejected, including five visual candidates. In particular, 2MASS J14493784+2355378 and 2MASS J14232186+6154005 (also a weak index-selected candidate),

---

<sup>3</sup>We do not explicitly include uncertainties for the absolute magnitude to spectral type relation, but the extensive number of binary templates we use already models the intrinsic scatter in the population.



two previously identified spectral binary candidates from Gizis et al. (2003) and Geißler et al. (2011) were rejected due to their low confidence level that the binary fit was statistically better than the single fit. Since our template sample includes a wide range of objects such as young and unusually blue and red dwarfs, the peculiarities of these candidates may be better explained by factors other than unresolved binarity. One exception to the index selection was 2MASS J1711457+223204 whose SpeX spectral type was too late to be included in the candidate sample, yet it was a visual candidate and passed the binary fit F-test. Figures 4 and 5 show the best single (left) and binary (right) template fits to our strong and weak candidates. Table 5 summarizes the results of these fits.

Upon further visual examination, some binary fits still proved unsatisfactory. This was the case for the blue L dwarfs 2MASS J11181292–0856106, 2MASS J14162409+1348267, 2MASS J15150083+4847416, 2MASS J17114558+40285779, and the subdwarfs 2MASS J03303847–2348463, 2MASS J03301720+3505001, 2MASS J04024315+1730136, 2MASS J15412408+5425598 and 2MASS J23311807+4607310. Section 5.1 discusses these issues in more detail. As a result, fourteen candidates have been recognized, of which eleven are newly identified.

In an effort to balance the tradeoff between fidelity of binary candidates and completeness, we are leaning towards the former. Our binary selection criteria are conservative and it is likely that other spectral binaries may be identified with slightly looser constraints.

## 4. Individual candidates

In summary, from the  $\sim 800$  sources compiled in the candidate sample, twelve were selected by visual inspection and thirty were selected by spectral indices. Seven sources overlapped the results of these selection methods. After fitting all thirty-five candidates, seventeen were rejected due to their confidence level being lower than 90%, and four more due to their unusually blue colors (See Section 5.1), leading to a final count of fourteen: six strong, seven weak and one visual candidate not overlapping with the index-selected. Labels of strong and weak candidates come from index selection.

### 4.1. Strong candidates

#### 4.1.1. 2MASS J02361794+0048548

Originally discovered by Geballe et al. (2002), 2MASS J0236+0048 was classified as an L6 in the optical and L6.5 in the infrared by Casewell et al. (2008). In their study, Casewell et al. (2008) comment that this object may belong to the Pleiades moving group, given its proper motion of  $[\mu_\alpha \cos \delta, \mu_\delta] = [161.33 \pm 10.10, 176.33 \pm 19.16]$  mas yr $^{-1}$  and agreement between photometric and moving group distances at  $d = 26$  pc. However, Scholz et al. (2009) reclassified this object as an L9, reducing its spectroscopic distance to 18 pc while its strong FeH band at  $0.99\mu\text{m}$  argues against low surface gravity (Allers et al. 2007). Nevertheless, the spectrum of this source does not show any signs of youth (Allers et al. 2007). 2MASS J0236+0048 is selected by eleven out of twelve spectral index combinations, and its binary fit is significantly better than its single fit, making this a strong binary candidate with  $L5.0 \pm 0.6$  and  $T1.9 \pm 1.1$  components.

#### 4.1.2. *SDSS J093113.09+280228.9*

Schmidt et al. (2010) discovered SDSS J0931+2802 in the SDSS catalog and classified it as an L3 at a mean distance of  $29 \pm 9$  pc. Its spectrum shows excess flux in the  $J$ -band at  $\sim 1.27 \mu\text{m}$  and a noticeable dip in the  $H$ -band in the vicinity of  $1.63 \mu\text{m}$ , as expected for a T dwarf component. This source was selected as a visual candidate, and by eleven out of twelve spectral index combinations, and our spectral fitting predicts component types of  $L1.4 \pm 0.1$  and  $T2.6 \pm 0.9$ .

#### 4.1.3. *2MASS J13114227+3629235*

Identified as a brown dwarf candidate by Zhang et al. (2009), 2MASS J1311+3629 is a peculiar L5. While also classified as unusually blue in wavelengths longer than  $J$  band (Mace et al. 2013), it lacks evidence of low metallicity or  $\text{H}_2$  collision-induced absorption (CIA) in  $H$  and  $K$  bands. Kirkpatrick et al. (2011) identified the methane feature in the  $H$  band centered around  $1.63 \mu\text{m}$  suggesting unresolved binarity. In this study, it was selected by eleven spectral index combinations and also as a visual candidate due to its methane absorption band starting at  $1.60 \mu\text{m}$ . Template fitting gives spectral types of  $L4.8 \pm 0.6$  and  $T4.1 \pm 2.7$ .

#### 4.1.4. *2MASS J13411160–30525049*

2MASS J1341–3052 was discovered by Reid et al. (2008) and classified as an L3 in the optical by Faherty et al. (2009), who also measured its parallax and distance ( $24 \pm 2$  pc). 2MASS J1341–3052 was selected by eight spectral indices, and its spectral fitting suggests component spectral types of  $L1.2 \pm 0.3$  and  $T6.3 \pm 1.0$ .

#### 4.1.5. *2MASS J14532589+1420418*

2MASS J1453+1420 was classified as an L1 in both the infrared (Kirkpatrick et al. 2010) and the optical (Schmidt et al. 2010), where it clearly shows excess flux in the  $J$  band and a dip in the  $H$  band. It is selected by eleven out of twelve spectral index combinations, and it is slightly blue with a  $J-K_s$  color of  $1.18 \pm 0.05$  as compared to the median for the L1 spectral type  $1.34 \pm 0.19$  (Schmidt et al. 2010). It is best fit by  $L1.1 \pm 0.0$  and  $T6.0 \pm 1.1$  components.

#### 4.1.6. *2MASS J20261584–2943124*

2MASS J2026–2943 had already been identified as a spectral binary candidate by Gelino & Burgasser (2010), but it failed to be resolved by Keck AO, thus setting an upper limit in separation of  $0''.25$  or a projected separation of 9 AU at a distance of  $36 \pm 5$  pc (Gelino & Burgasser 2010). This source clearly shows a dip in its spectrum centered at  $1.63 \mu\text{m}$ , and it is best fit by a combination of  $L1.0 \pm 0.5$  and  $T5.8 \pm 1.0$  components.



## 4.2. Weak Candidates

### 4.2.1. 2MASS J02060879+22355930

2MASS J0206+2235 was discovered and classified as an L5.5 by Chiu et al. (2006), and characterized as a blue L dwarf by Schneider et al. (2014). It was selected by seven spectral index combinations and fit to  $L5.1\pm0.5$  and  $T3.2\pm2.3$  components.

### 4.2.2. DENIS-P J04272708–1127143

2MASS J0427–1127 was discovered and classified as an M7 by Martín et al. (2010). It was selected by five spectral index combinations and best fit by  $M7.4\pm0.2$  and  $T5.1\pm1.5$  components.

### 4.2.3. 2MASS J10365305–3441380

2MASS J1036–3441 was classified as an L6 (Gizis 2002) at a distance of  $21\pm3$  pc. It almost made the cut for a strong candidate, since it was selected by seven spectral index combinations. This source was best fit by components with  $L5.2\pm0.4$  and  $T1.4\pm0.4$  spectral types. Despite not having a pronounced methane absorption feature centered at  $1.63\ \mu\text{m}$ , the binary fit is significantly better than the single fit, especially at the  $J$  band peak.

### 4.2.4. 2MASS J10595138–2113082

2MASS J1059–2113 is an L1 (Cruz et al. 2003) at a distance of  $32.1\pm2.2$  pc. This source was selected by four spectral index combinations and its best binary fit yields components with  $L0.6\pm0.4$  and  $T3.4\pm1.3$  spectral types. Its spectrum shows a strong absorption feature centered at  $1.63\ \mu\text{m}$ , as well as a flux excess at  $1.23\ \mu\text{m}$  and  $2.20\ \mu\text{m}$ .

### 4.2.5. SDSS J142227.20+221557.5

SDSS J1422+2215 was identified and classified as an L6 in the NIR by Chiu et al. (2006) and also as an unusually blue L dwarf, showing strong  $\text{H}_2\text{O}$  and  $\text{FeH}$  absorption bands, which may be due to subsolar metallicity and/or thinner condensate cloud decks. It was selected by four out of twelve spectral index combinations with most likely component spectral types of  $L4.2\pm0.6$  and  $T4.1\pm2.3$ .

### 4.2.6. WISE J16235970–0508114

WISE J1623–0508 was classified as an L1 in the NIR (Thompson et al. 2013). This source was selected by four spectral index combinations and best fit by  $L0.6\pm0.3$  and  $T6.0\pm0.3$  components.

#### 4.2.7. 2MASS J17072529–0138093

2MASS J1707–0138 was discovered and classified as an L2 by Martín et al. (2010). Selected by five spectral index combinations, its spectrum is best fit by components with  $L0.7\pm0.5$  and  $T4.3\pm2.0$  spectral types. Its spectrum shows a strong absorption feature centered at  $1.63\mu\text{m}$ .

### 4.3. Visual Candidates

#### 4.3.1. 2MASS J1711457+223204

2MASS J1711+2232 was first identified and classified as an L6.5 in the optical by Kirkpatrick et al. (2000). Due to its FeH and CH<sub>4</sub> absorption features in the *H* band, Burgasser et al. (2010a) suggested it could be a spectral binary with L5.0 and T5.5 components. We find slightly different component spectral types of  $L1.5\pm0.6$  and  $T2.5\pm1.0$ , yet this source was not selected by spectral indices because of its late SpeX spectral type of L8.8. Despite having been imaged with HST/WFPC, it remains unresolved (Gizis et al. 2003).

## 5. Discussion

### 5.1. Blue L dwarfs as contaminants

Four of the candidates selected by spectral indices were rejected after spectral fitting due to their poor binary fits. When we investigated these sources in detail, we found they were classified as blue objects in the literature and/or showed an unusually blue spectrum. 2MASS J11181292–0856106 was classified as a metal-poor subdwarf by Kirkpatrick et al. (2010). SDSS J141624.09+134826.7 is part of a resolved binary system with a T7.5 companion (Burningham et al. 2010; Burgasser et al. 2010b; Scholz 2010) that is itself a blue outlier. Bowler et al. (2010) rejected unresolved binarity for the primary based on a qualitative comparison to the unusually blue L dwarf 2MASS J11263991–5003550. The L6 2MASS J15150083+4847416 shows a stable RV of  $-29.97\pm0.14\text{ km s}^{-1}$  (Wilson et al. 2003) and no signs of binarity from its spectrum. Finally, 2MASS J17114558+40285779 was discovered by Radigan et al. (2008) as an unusually blue wide companion to the K star G203-50. They discuss the possibility that the object may be unusual due to unresolved binarity, but argue in favor of low metallicity. For all of these sources, the lack of single templates akin to blue objects resulted in statistically better binary fits, yet the match is still relatively poor around the  $1.63\mu\text{m}$  methane absorption feature.

A few more previously unidentified NIR subdwarfs were also selected as weak candidates and subsequently rejected due to their poor binary fits. The best binary fits for 2MASS J03303847–2348463, 2MASS J03301720+3505001, 2MASS J04024315+1730136, 2MASS J15412408+5425598, and 2MASS J23311807+4607310 use another subdwarf as a primary, which again indicates that they are part of a rare blue population that has a short supply of examples in this sample.

M+T binaries have slightly bluer spectra caused by the extra flux in the *J* band corresponding to the peak in the T dwarfs. Particularly, some sources originally classified as unusually blue have been later identified as spectral binaries (e.g. SDSS J0805+4812 Burgasser 2007b; Dupuy & Liu 2012). In contrast, intrinsically blue L dwarfs have low metallicity, thin cloud coverage, large-grain clouds or a combination

of these, causing a blue tilt to the NIR spectrum (Schmidt et al. 2010; Burgasser et al. 2008b; Cruz et al. 2007). Faherty et al. (2009) have defined red and blue photometric outliers as the objects whose  $J-K_s$  color placed them  $2\sigma$  or 0.4 mag away from the average for their spectral type, while pointing out the difficulty to distinguish outliers beyond a spectral type of L9 due to the small sample of objects. Figure 8 shows the  $J-K$  colors for our sample as compared to their spectral types, including the median and  $\pm 2\sigma$  lines as calculated from the sample (solid lines) and reported in the literature (dashed lines) by West et al. (2011) and Schmidt et al. (2010) for samples of M and L dwarfs, respectively. Figure 8 suggests that blue L dwarfs are a major contaminant in our sample since a significant fraction of both known binaries and candidates have similar colors and thus lie in the same region as blue sources. We conclude that the blue L dwarf contaminants can be recognized if rejected due to their poor fits to binary template spectra.

## 5.2. Separation distribution of binary systems

True confirmation of our candidates requires observational follow-up to either resolve the systems or measure RV or astrometric variability. As noted in the introduction, spectral binaries can be used to devise an unbiased method to measure the VLM binary separation distribution. Therefore, it is worth examining the separation distribution of VLM and brown dwarf spectral binaries confirmed to date, to see if there are any differences compared to the resolved population.

Figure 6 shows the distribution of projected separations from 122 confirmed VLM binaries<sup>4</sup>. Among the observational methods for detecting binaries, such as direct imaging, radial velocity variations, astrometric variations, and microlensing, direct imaging has proven to be the most successful so far (73% of confirmed VLM binaries), but its biggest drawback is its limit in resolution. At minimum angular scales of  $0''.1$ – $0''.2$  for AO and HST programs, and typical distances of field brown dwarfs of 20–30 pc, telescope sensitivity reaches its limit at separations of around 2–6 AU. At 2.90 AU, the mean projected separation of eight independently-confirmed spectral binaries plotted in Figure 6 falls at the lower end of this sensitivity limit, at less than the mean of known VLM binaries excluding the spectral binaries (3.75 AU), raising the possibility that there may be significantly more tightly bound systems.

To assess whether this is a significant difference, we performed a two-sample Kolmogorov-Smirnov test comparing the projected separation distributions of all binary systems to the confirmed spectral binaries. Specifically, the distributions were constrained in angular separation to 50–500 mas, where the lower limit corresponds to the smallest possible imaging resolution in good seeing, while the upper limit restricts the maximum size of the slit. In addition, the distance was constrained to less than 30 pc, since objects that are farther away would be more difficult to confirm as binaries. In this way, we intend to fairly compare the spectral binary method to the other available methods for binary detection. These constraints reduced the number of spectral binaries to six. The result was a D statistic of 0.41 and a probability of 25%. While the low probability is indicative of a difference between the samples, the small sample size makes this statistic inconclusive. Many more of the existing spectral binaries need to be characterized before a significant difference can be confirmed or ruled out.

---

<sup>4</sup>Based on the compilation at the Very-Low-Mass Binaries Archive, <http://www.vlmbinaries.org>, and more recent discoveries by Choi et al. (2013); Duchêne et al. (2013); Luhman (2013); Radigan et al. (2013); Sahlmann et al. (2013); Burgasser et al. (2012); Liu et al. (2012); Artigau et al. (2011); Burgasser et al. (2011b); Dhital et al. (2011); Gelino et al. (2011); Geißler et al. (2011); Liu et al. (2011); Allers et al. (2010); Burgasser et al. (2010a); Hwang et al. (2010); Stumpf et al. (2010); Allers et al. (2009); Luhman et al. (2009).

## 6. Summary

We have identified fourteen brown dwarf binary candidates with late-M/early-L plus T dwarf components based on visual inspection of low resolution data, and analysis with spectral indices and template fitting. We combined five new spectral indices, with previously defined ones, spectral type, and  $J-H$ ,  $H-K_s$ , and  $J-K_s$  colors to define pairings that effectively select spectral binary candidates, and confirmed them by comparison to both single and binary template spectra from the SpeX Prism Library. Unusually blue L dwarfs were the main contaminant of this analysis, with four candidates classified as unusually blue but nonetheless being poorly matched to binary spectra. Exploring the separation distribution of binary systems we find suggestive evidence that spectral binaries are more closely separated than other binaries, but the confirmed sample is too small to be conclusive. We are now undertaking follow-up AO imaging and RV monitoring of these candidates to confirm them and measure orbital properties.

## Acknowledgments

The authors thank telescope operators for their assistance during our observations. DBG would like to thank the Friends of the International Center at UCSD for their generous scholarship as well as Davy Kirkpatrick and fellow graduate students Alex Mendez and David Vidmar for their helpful discussion and coding tips. This publication makes use of data from the SpeX Prism Spectral Libraries, maintained by Adam Burgasser at <http://www.browndwarfs.org/spexprism>; the Dwarf Archives Compendium, maintained by Chris Gelino at <http://DwarfArchives.org>; and the VLM Binaries Archive maintained by Nick Siegler at <http://vlmbinaries.org>. The authors wish to recognize and acknowledge the very significant cultural role and reverence that the summit of Mauna Kea has always had within the indigenous Hawaiian community. We are most fortunate to have the opportunity to conduct observations from this mountain.

*Facilities:* IRTF (SpeX).

## REFERENCES

- Allen, P. R. 2007, ApJ, 668, 492, 492
- Allers, K. N., & Liu, M. C. 2013, ApJ, 772, 79, 79
- Allers, K. N., Liu, M. C., Dupuy, T. J., & Cushing, M. C. 2010, ApJ, 715, 561, 561
- Allers, K. N., Jaffe, D. T., Luhman, K. L., et al. 2007, ApJ, 657, 511, 511
- Allers, K. N., Liu, M. C., Shkolnik, E., et al. 2009, ApJ, 697, 824, 824
- Andrei, A. H., Smart, R. L., Penna, J. L., et al. 2011, AJ, 141, 54, 54
- Artigau, É., Lafrenière, D., Doyon, R., et al. 2011, ApJ, 739, 48, 48
- Basri, G., Mohanty, S., Allard, F., et al. 2000, ApJ, 538, 363, 363
- Basri, G., & Reiners, A. 2006, AJ, 132, 663, 663
- Becklin, E. E., & Zuckerman, B. 1988, Nature, 336, 656, 656

- Berriman, B., Kirkpatrick, D., Hanisch, R., Szalay, A., & Williams, R. 2003, in IAU Joint Discussion, Vol. 8, IAU Joint Discussion
- Bessell, M. S. 1991, *AJ*, 101, 662, 662
- Billères, M., Delfosse, X., Beuzit, J.-L., et al. 2005, *A&A*, 440, L55, L55
- Blake, C. H., Charbonneau, D., & White, R. J. 2010, *ApJ*, 723, 684, 684
- Blake, C. H., Charbonneau, D., White, R. J., et al. 2008, *ApJ*, 678, L125, L125
- Bochanski, J. J., Hawley, S. L., Covey, K. R., et al. 2010, *AJ*, 139, 2679, 2679
- Bochanski, J. J., Hawley, S. L., & West, A. A. 2011, *AJ*, 141, 98, 98
- Boeshaar, P. C., & Tyson, J. A. 1985, *AJ*, 90, 817, 817
- Bouy, H., Brandner, W., Martín, E. L., et al. 2003, *AJ*, 126, 1526, 1526
- Bowler, B. P., Liu, M. C., & Dupuy, T. J. 2010, *ApJ*, 710, 45, 45
- Burgasser, A. J. 2007a, *ApJ*, 659, 655, 655
- . 2007b, *AJ*, 134, 1330, 1330
- Burgasser, A. J., Bardalez-Gagliuffi, D. C., & Gizis, J. E. 2011a, *AJ*, 141, 70, 70
- Burgasser, A. J., & Blake, C. H. 2009, *AJ*, 137, 4621, 4621
- Burgasser, A. J., Cruz, K. L., Cushing, M., et al. 2010a, *ApJ*, 710, 1142, 1142
- Burgasser, A. J., Cruz, K. L., & Kirkpatrick, J. D. 2007a, *ApJ*, 657, 494, 494
- Burgasser, A. J., Geballe, T. R., Leggett, S. K., Kirkpatrick, J. D., & Golimowski, D. A. 2006a, *ApJ*, 637, 1067, 1067
- Burgasser, A. J., Kirkpatrick, J. D., Cruz, K. L., et al. 2006b, *ApJS*, 166, 585, 585
- Burgasser, A. J., Liu, M. C., Ireland, M. J., Cruz, K. L., & Dupuy, T. J. 2008a, *ApJ*, 681, 579, 579
- Burgasser, A. J., Looper, D., & Rayner, J. T. 2010b, *AJ*, 139, 2448, 2448
- Burgasser, A. J., Looper, D. L., Kirkpatrick, J. D., Cruz, K. L., & Swift, B. J. 2008b, *ApJ*, 674, 451, 451
- Burgasser, A. J., Luk, C., Dhital, S., et al. 2012, *ApJ*, 757, 110, 110
- Burgasser, A. J., Reid, I. N., Siegler, N., et al. 2007b, *Protostars and Planets V*, 427, 427
- Burgasser, A. J., Sitarski, B. N., Gelino, C. R., Logsdon, S. E., & Perrin, M. D. 2011b, *ApJ*, 739, 49, 49
- Burgasser, A. J., Kirkpatrick, J. D., Brown, M. E., et al. 2002, *ApJ*, 564, 421, 421
- Burningham, B., Leggett, S. K., Lucas, P. W., et al. 2010, *MNRAS*, 404, 1952, 1952
- Burrows, A., Marley, M., Hubbard, W. B., et al. 1997, *ApJ*, 491, 856, 856
- Caballero, J. A. 2007, *ApJ*, 667, 520, 520

- Carson, J. C., Marengo, M., Patten, B. M., et al. 2011, *ApJ*, 743, 141, 141
- Casewell, S. L., Jameson, R. F., & Burleigh, M. R. 2008, *MNRAS*, 390, 1517, 1517
- Chappelle, R. J., Pinfield, D. J., Steele, I. A., Dobbie, P. D., & Magazzù, A. 2005, *MNRAS*, 361, 1323, 1323
- Chiu, K., Fan, X., Leggett, S. K., et al. 2006, *AJ*, 131, 2722, 2722
- Choi, J.-Y., Han, C., Udalski, A., et al. 2013, *ApJ*, 768, 129, 129
- Close, L. M., Siegler, N., Freed, M., & Biller, B. 2003, *ApJ*, 587, 407, 407
- Cruz, K., Faherty, J., Rice, E., Riedel, A., & Núñez, A. 2013, in *Protostars and Planets VI*, Heidelberg, July 15-20, 2013. Poster #2G022, 22
- Cruz, K. L., Burgasser, A. J., Reid, I. N., & Liebert, J. 2004, *ApJ*, 604, L61, L61
- Cruz, K. L., Kirkpatrick, J. D., & Burgasser, A. J. 2009, *AJ*, 137, 3345, 3345
- Cruz, K. L., Reid, I. N., Liebert, J., Kirkpatrick, J. D., & Lowrance, P. J. 2003, *AJ*, 126, 2421, 2421
- Cruz, K. L., Reid, I. N., Kirkpatrick, J. D., et al. 2007, *AJ*, 133, 439, 439
- Cushing, M. C., Rayner, J. T., Davis, S. P., & Vacca, W. D. 2003, *ApJ*, 582, 1066, 1066
- Cushing, M. C., Vacca, W. D., & Rayner, J. T. 2004, *PASP*, 116, 362, 362
- Cushing, M. C., Roellig, T. L., Marley, M. S., et al. 2006, *ApJ*, 648, 614, 614
- Cushing, M. C., Marley, M. S., Saumon, D., et al. 2008, *ApJ*, 678, 1372, 1372
- Day-Jones, A. C., Marocco, F., Pinfield, D. J., et al. 2013, *MNRAS*, 648, 648
- Deacon, N. R., Hambly, N. C., & Cooke, J. A. 2005, *A&A*, 435, 363, 363
- Deacon, N. R., Hambly, N. C., King, R. R., & McCaughrean, M. J. 2009, *MNRAS*, 394, 857, 857
- Delfosse, X., Tinney, C. G., Forveille, T., et al. 1999, *A&AS*, 135, 41, 41
- Delgado-Donate, E. J., Clarke, C. J., Bate, M. R., & Hodgkin, S. T. 2004, *MNRAS*, 351, 617, 617
- Dhital, S., Burgasser, A. J., Looper, D. L., & Stassun, K. G. 2011, *AJ*, 141, 7, 7
- Duchêne, G., Bouvier, J., Moraux, E., et al. 2013, *A&A*, 555, A137, A137
- Dupuy, T. J., & Liu, M. C. 2012, *ApJS*, 201, 19, 19
- Dupuy, T. J., Liu, M. C., & Ireland, M. J. 2009, *ArXiv e-prints*, arXiv:0912.0738
- EROS Collaboration, Goldman, B., Delfosse, X., et al. 1999, *A&A*, 351, L5, L5
- Faherty, J. K., Burgasser, A. J., Cruz, K. L., et al. 2009, *AJ*, 137, 1, 1
- Faherty, J. K., Burgasser, A. J., Walter, F. M., et al. 2012, *ApJ*, 752, 56, 56
- Fan, X., Knapp, G. R., Strauss, M. A., et al. 2000, *AJ*, 119, 928, 928

- Fischer, D. A., & Marcy, G. W. 1992, *ApJ*, 396, 178, 178
- Folkes, S. L., Pinfield, D. J., Jones, H. R. A., et al. 2012, *MNRAS*, 427, 3280, 3280
- Forveille, T., Ségransan, D., Delorme, P., et al. 2004, *A&A*, 427, L1, L1
- Geballe, T. R., Knapp, G. R., Leggett, S. K., et al. 2002, *ApJ*, 564, 466, 466
- Geißler, K., Metchev, S., Kirkpatrick, J. D., Berriman, G. B., & Looper, D. 2011, *ApJ*, 732, 56, 56
- Gelino, C. R., & Burgasser, A. J. 2010, *AJ*, 140, 110, 110
- Gelino, C. R., Kirkpatrick, J. D., Cushing, M. C., et al. 2011, *AJ*, 142, 57, 57
- Gizis, J. E. 2002, *ApJ*, 575, 484, 484
- Gizis, J. E., Monet, D. G., Reid, I. N., Kirkpatrick, J. D., & Burgasser, A. J. 2000a, *MNRAS*, 311, 385, 385
- Gizis, J. E., Monet, D. G., Reid, I. N., et al. 2000b, *AJ*, 120, 1085, 1085
- Gizis, J. E., Reid, I. N., Knapp, G. R., et al. 2003, *AJ*, 125, 3302, 3302
- Golimowski, D. A., Henry, T. J., Krist, J. E., et al. 2004, *AJ*, 128, 1733, 1733
- Hall, P. B. 2002, *ApJ*, 580, L77, L77
- Haro, G., & Chavira, E. 1966, *Vistas in Astronomy*, 8, 89, 89
- Hawley, S. L., Covey, K. R., Knapp, G. R., et al. 2002, *AJ*, 123, 3409, 3409
- Hayashi, C., & Nakano, T. 1963, *Progress of Theoretical Physics*, 30, 460, 460
- Hwang, K.-H., Udalski, A., Han, C., et al. 2010, *ApJ*, 723, 797, 797
- Irwin, M., McMahon, R. G., & Reid, N. 1991, *MNRAS*, 252, 61P, 61P
- Jenkins, J. S., Ramsey, L. W., Jones, H. R. A., et al. 2009, *ApJ*, 704, 975, 975
- Joergens, V. 2008, *A&A*, 492, 545, 545
- Kendall, T. R., Delfosse, X., Martín, E. L., & Forveille, T. 2004, *A&A*, 416, L17, L17
- Kendall, T. R., Jones, H. R. A., Pinfield, D. J., et al. 2007, *MNRAS*, 374, 445, 445
- Kendall, T. R., Mauron, N., Azzopardi, M., & Gigoyan, K. 2003, *A&A*, 403, 929, 929
- Kirkpatrick, J. D. 2005, *ARA&A*, 43, 195, 195
- Kirkpatrick, J. D., Henry, T. J., & Simons, D. A. 1995, *AJ*, 109, 797, 797
- Kirkpatrick, J. D., Reid, I. N., Liebert, J., et al. 1999, *ApJ*, 519, 802, 802
- . 2000, *AJ*, 120, 447, 447
- Kirkpatrick, J. D., Cruz, K. L., Barman, T. S., et al. 2008, *ApJ*, 689, 1295, 1295
- Kirkpatrick, J. D., Looper, D. L., Burgasser, A. J., et al. 2010, *ApJS*, 190, 100, 100



- Kirkpatrick, J. D., Cushing, M. C., Gelino, C. R., et al. 2011, *ApJS*, 197, 19, 19
- Knapp, G. R., Leggett, S. K., Fan, X., et al. 2004, *AJ*, 127, 3553, 3553
- Kraus, A. L., & Hillenbrand, L. A. 2012, *ApJ*, 757, 141, 141
- Kumar, S. S. 1963, *ApJ*, 137, 1121, 1121
- Lépine, S., Rich, R. M., Neill, J. D., Caulet, A., & Shara, M. M. 2002, *ApJ*, 581, L47, L47
- Lépine, S., Rich, R. M., & Shara, M. M. 2003, *AJ*, 125, 1598, 1598
- Liebert, J. 1976, *PASP*, 88, 232, 232
- Liebert, J., & Gizis, J. E. 2006, *PASP*, 118, 659, 659
- Liu, M. C., Dupuy, T. J., Bowler, B. P., Leggett, S. K., & Best, W. M. J. 2012, *ApJ*, 758, 57, 57
- Liu, M. C., Dupuy, T. J., & Leggett, S. K. 2010, *ApJ*, 722, 311, 311
- Liu, M. C., Delorme, P., Dupuy, T. J., et al. 2011, *ApJ*, 740, 108, 108
- Lodieu, N., Scholz, R.-D., & McCaughrean, M. J. 2002, *A&A*, 389, L20, L20
- Lodieu, N., Scholz, R.-D., McCaughrean, M. J., et al. 2005, *A&A*, 440, 1061, 1061
- Looper, D. L., Gelino, C. R., Burgasser, A. J., & Kirkpatrick, J. D. 2008a, *ApJ*, 685, 1183, 1183
- Looper, D. L., Kirkpatrick, J. D., Cutri, R. M., et al. 2008b, *ApJ*, 686, 528, 528
- Luhman, K. L. 2013, *ApJ*, 767, L1, L1
- Luhman, K. L., Mamajek, E. E., Allen, P. R., Muench, A. A., & Finkbeiner, D. P. 2009, *ApJ*, 691, 1265, 1265
- Mace, G. N., Kirkpatrick, J. D., Cushing, M. C., et al. 2013, *ApJS*, 205, 6, 6
- Manjavacas, E., Goldman, B., Reffert, S., & Henning, T. 2013, *ArXiv e-prints*, arXiv:1310.2191
- Martín, E. L., Delfosse, X., Basri, G., et al. 1999, *AJ*, 118, 2466, 2466
- Martín, E. L., Phan-Bao, N., Bessell, M., et al. 2010, *A&A*, 517, A53, A53
- McElwain, M. W., & Burgasser, A. J. 2006, *AJ*, 132, 2074, 2074
- Metchev, S. A., Kirkpatrick, J. D., Berriman, G. B., & Looper, D. 2008, *ApJ*, 676, 1281, 1281
- Padoan, P., & Nordlund, Å. 2002, *ApJ*, 576, 870, 870
- Phan-Bao, N. 2011, *Astronomische Nachrichten*, 332, 668, 668
- Phan-Bao, N., Crifo, F., Delfosse, X., et al. 2003, *A&A*, 401, 959, 959
- Phan-Bao, N., Bessell, M. S., Martín, E. L., et al. 2008, *MNRAS*, 383, 831, 831
- Pinfield, D. J., Dobbie, P. D., Jameson, R. F., et al. 2003, *MNRAS*, 342, 1241, 1241

- Pokorny, R. S., Jones, H. R. A., Hambly, N. C., & Pinfield, D. J. 2004, *A&A*, 421, 763, 763
- Radigan, J., Jayawardhana, R., Lafrenière, D., et al. 2013, *ApJ*, 778, 36, 36
- Radigan, J., Lafrenière, D., Jayawardhana, R., & Doyon, R. 2008, *ApJ*, 689, 471, 471
- Rayner, J. T., Toomey, D. W., Onaka, P. M., et al. 2003, *PASP*, 115, 362, 362
- Rebolo, R., Zapatero Osorio, M. R., Madrugá, S., et al. 1998, *Science*, 282, 1309, 1309
- Reid, I. N., Cruz, K. L., Kirkpatrick, J. D., et al. 2008, *AJ*, 136, 1290, 1290
- Reid, I. N., & Gizis, J. E. 2005, *PASP*, 117, 676, 676
- Reipurth, B., & Clarke, C. 2001, *AJ*, 122, 432, 432
- Ruiz, M. T., & Takamiya, M. Y. 1995, *AJ*, 109, 2817, 2817
- Sahlmann, J., Lazorenko, P. F., Ségransan, D., et al. 2013, *A&A*, 556, A133, A133
- Salim, S., Lépine, S., Rich, R. M., & Shara, M. M. 2003, *ApJ*, 586, L149, L149
- Schmidt, S. J., West, A. A., Hawley, S. L., & Pineda, J. S. 2010, *AJ*, 139, 1808, 1808
- Schneider, A. C., Cushing, M. C., Kirkpatrick, J. D., et al. 2014, *AJ*, 147, 34, 34
- Schneider, D. P., Knapp, G. R., Hawley, S. L., et al. 2002, *AJ*, 123, 458, 458
- Scholz, R.-D. 2010, *A&A*, 510, L8, L8
- . 2013, *ArXiv e-prints*, arXiv:1311.2716
- Scholz, R.-D., Lodieu, N., & McCaughrean, M. J. 2004, *A&A*, 428, L25, L25
- Scholz, R.-D., Meusinger, H., & Jahreiß, H. 2001, *A&A*, 374, L12, L12
- Scholz, R.-D., Storm, J., Knapp, G. R., & Zinnecker, H. 2009, *A&A*, 494, 949, 949
- Shkolnik, E., Liu, M. C., & Reid, I. N. 2009, *ApJ*, 699, 649, 649
- Shkolnik, E. L., Anglada-Escudé, G., Liu, M. C., et al. 2012, *ApJ*, 758, 56, 56
- Shu, F. H., Adams, F. C., & Lizano, S. 1987, *ARA&A*, 25, 23, 23
- Stamatellos, D., & Whitworth, A. P. 2009, *MNRAS*, 392, 413, 413
- Stumpf, M. B., Brandner, W., Bouy, H., Henning, T., & Hippler, S. 2010, *A&A*, 516, A37, A37
- Stumpf, M. B., Brandner, W., Henning, T., et al. 2008, *ArXiv e-prints*, arXiv:0811.0556
- Stumpf, M. B., Geißler, K., Bouy, H., et al. 2011, *A&A*, 525, A123, A123
- Thompson, M. A., Kirkpatrick, J. D., Mace, G. N., et al. 2013, *PASP*, 125, 809, 809
- Tinney, C. G., Delfosse, X., Forveille, T., & Allard, F. 1998, *A&A*, 338, 1066, 1066
- Tinney, C. G., Mould, J. R., & Reid, I. N. 1993, *AJ*, 105, 1045, 1045

- Vacca, W. D., Cushing, M. C., & Rayner, J. T. 2003, *PASP*, 115, 389, 389
- van Biesbroeck, G. 1961, *AJ*, 66, 528, 528
- West, A. A., Hawley, S. L., Bochanski, J. J., et al. 2008, *AJ*, 135, 785, 785
- West, A. A., Morgan, D. P., Bochanski, J. J., et al. 2011, *AJ*, 141, 97, 97
- Whitworth, A. P., & Zinnecker, H. 2004, *A&A*, 427, 299, 299
- Wilson, J. C., Kirkpatrick, J. D., Gizis, J. E., et al. 2001, *AJ*, 122, 1989, 1989
- Wilson, J. C., Miller, N. A., Gizis, J. E., et al. 2003, in *IAU Symposium*, Vol. 211, *Brown Dwarfs*, ed. E. Martín, 197
- York, D. G., Adelman, J., Anderson, Jr., J. E., et al. 2000, *AJ*, 120, 1579, 1579
- Zhang, Z. H., Pokorny, R. S., Jones, H. R. A., et al. 2009, *A&A*, 497, 619, 619
- Zhang, Z. H., Pinfield, D. J., Day-Jones, A. C., et al. 2010, *MNRAS*, 404, 1817, 1817

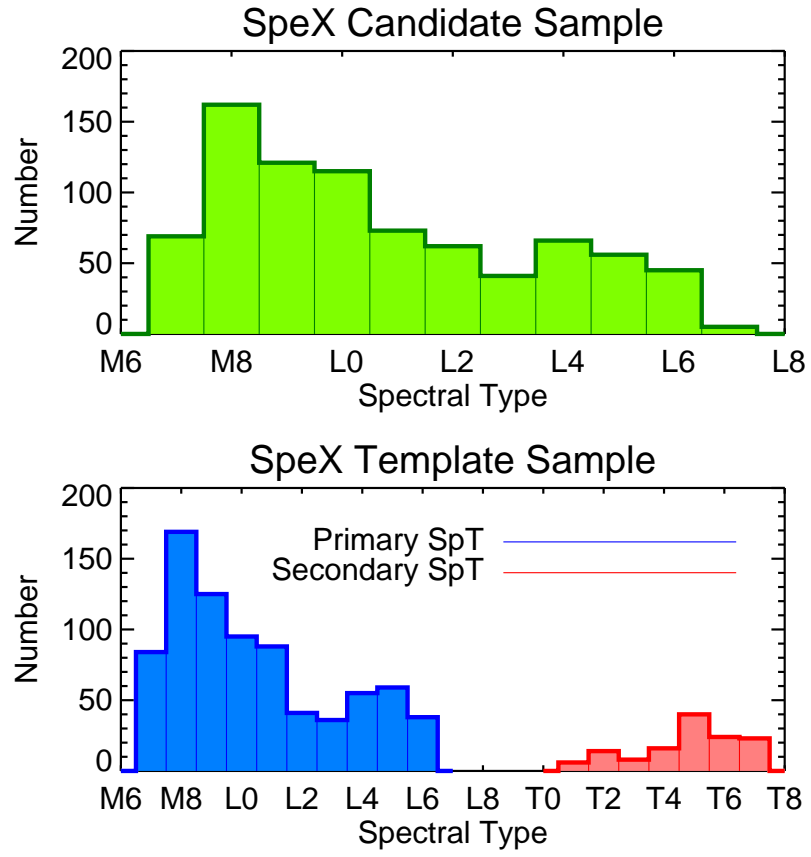


Fig. 1.— Distribution of SpeX spectral types in the samples used for selecting candidates (top) and template fitting (bottom).

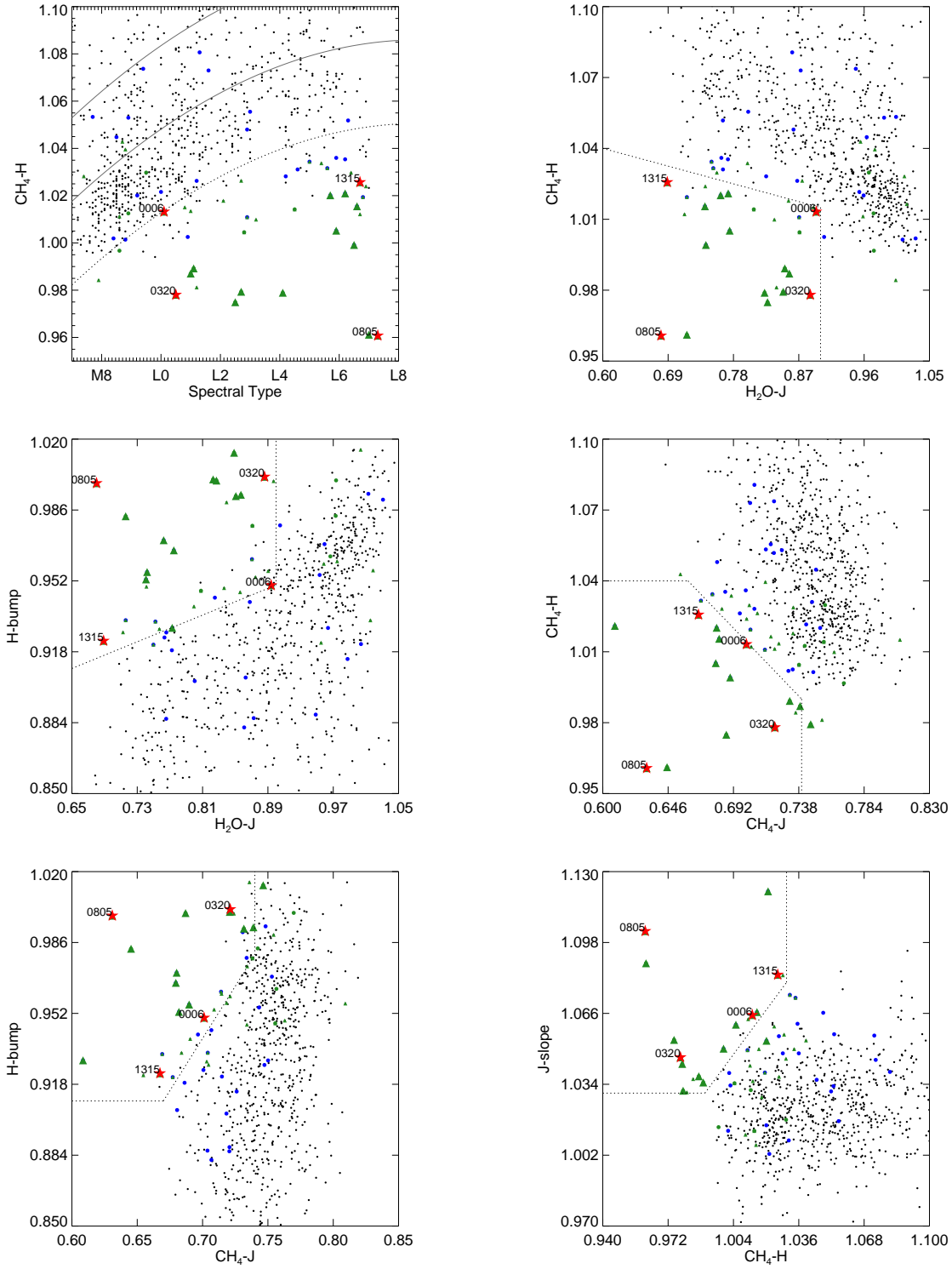


Fig. 2.— Index selection of spectral binary candidates. The indices calculated from the candidate sample of SpeX spectra are shown in black. The labeled red stars represent the four binary benchmarks. Unusually blue sources are plotted as blue circles, while the large and small green triangles show the strong and weak candidates, respectively. The green circles represent the visual candidates.

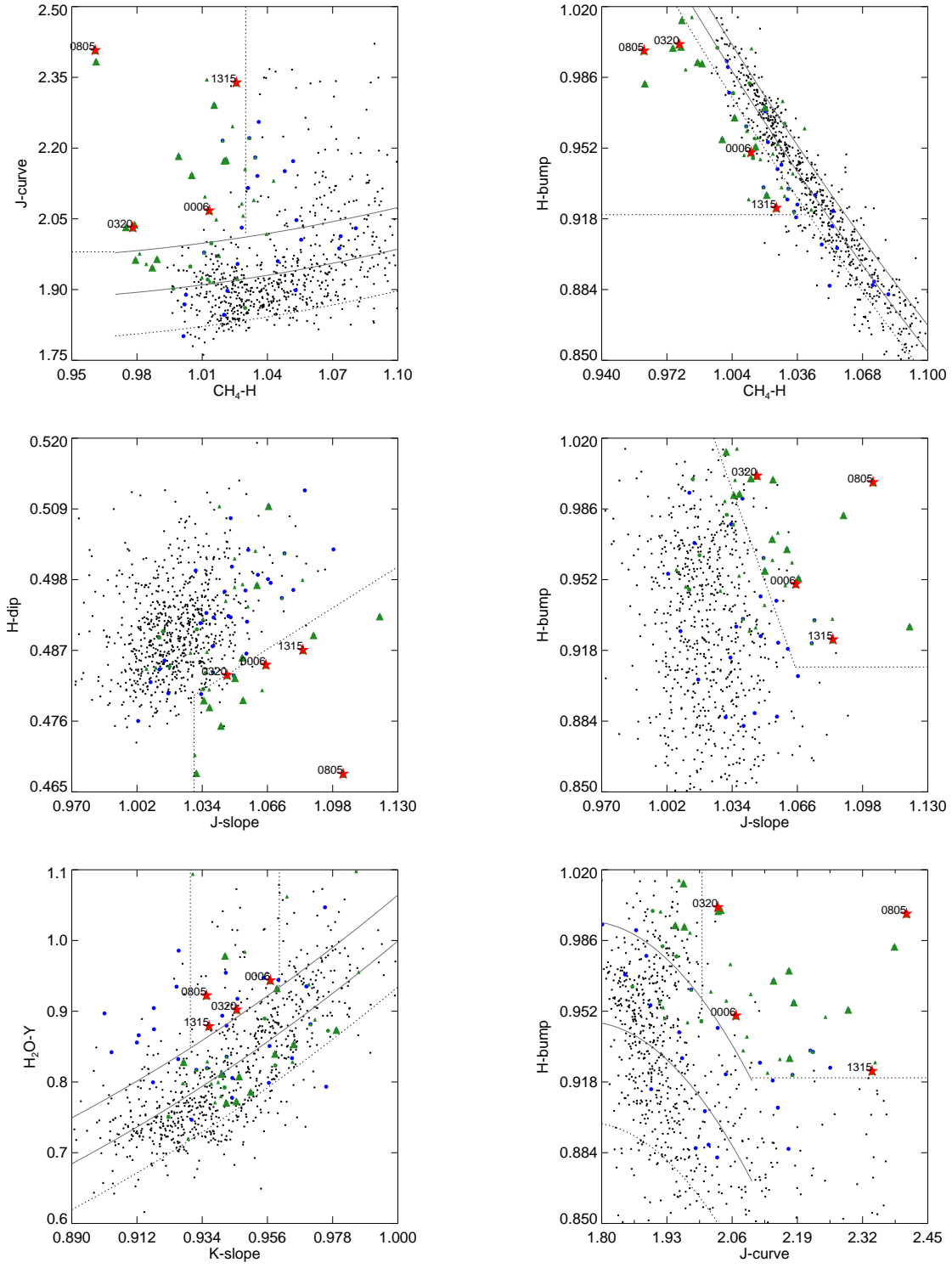


Fig. 2.— Continued.

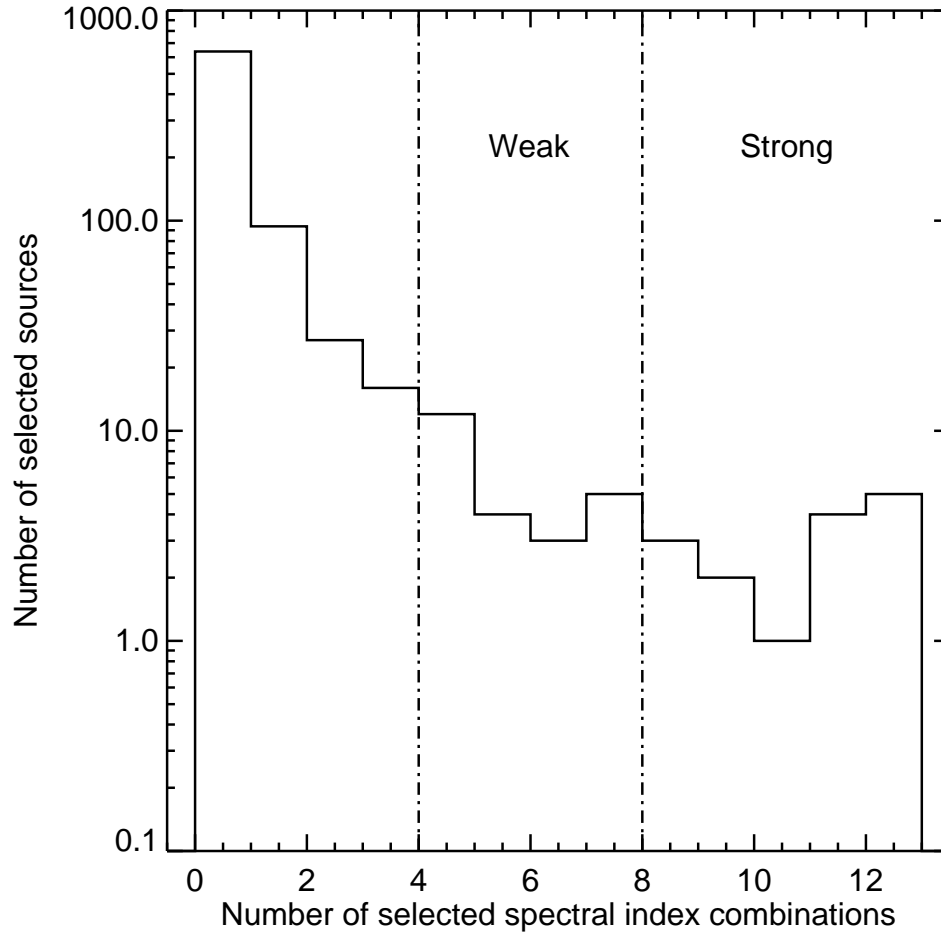


Fig. 3.— The number of sources satisfying index combinations versus total number of combinations. Sources selected 8 or more times are considered *strong* candidates. Sources selected between 4 and 8 times are considered *weak* candidates.



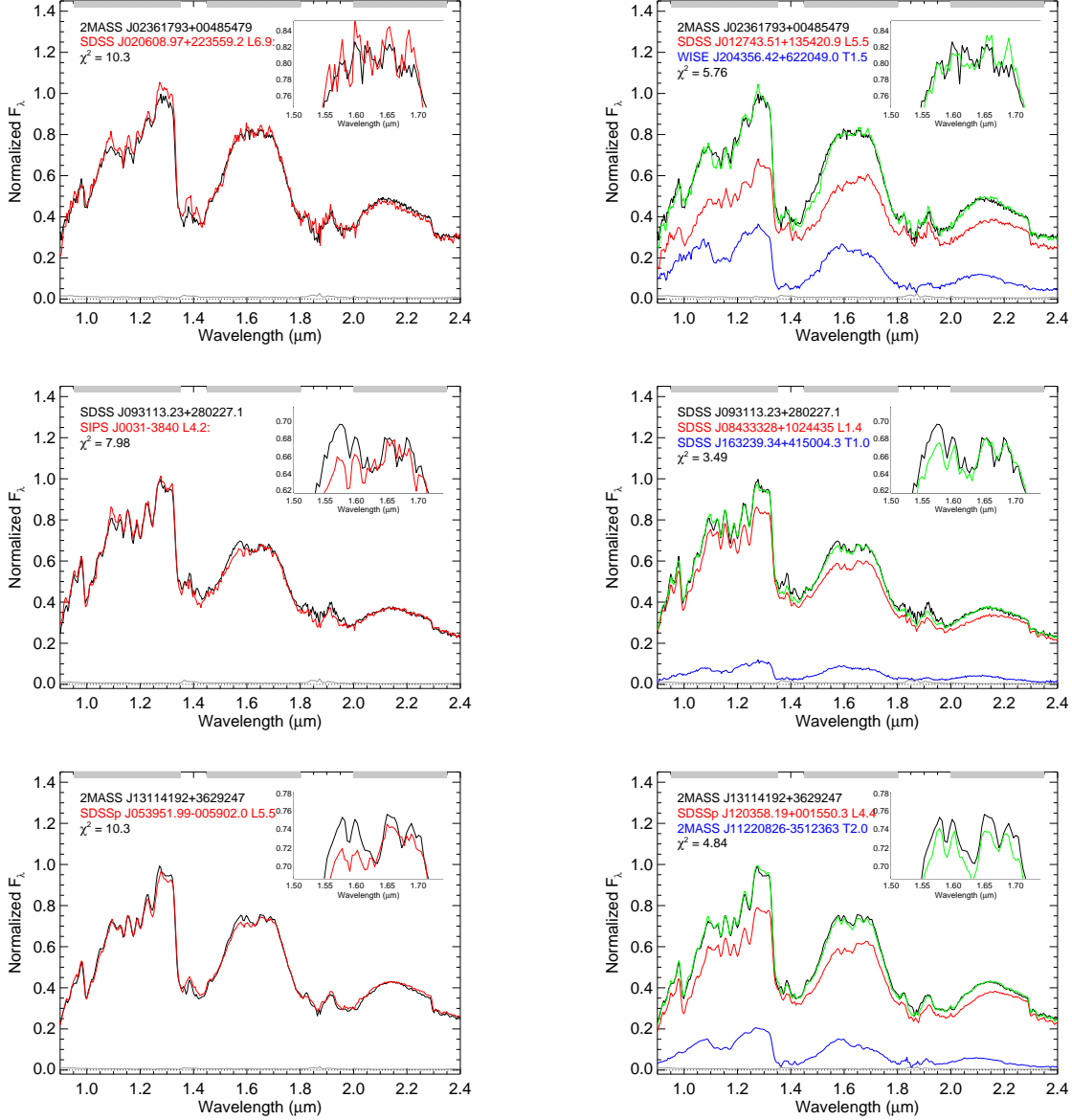


Fig. 4.— Best fits to single (left) and binary (right) templates for our strong candidates. The black line shows the candidate spectrum. For the single fits, the red line is the best single template. For the binary fits, the green line is the best binary template, which is the addition of the red (primary) and blue (secondary) lines. The gray line represents the uncertainty in the candidate spectrum. The gray horizontal bars at the top of the figures mark the parts of the spectrum being fit, while water absorption dominates the gaps. Notice the significant fitting improvement on the binary fits as compared to the single fits, particularly around the methane absorption feature centered at 1.63  $\mu\text{m}$  (see inset).

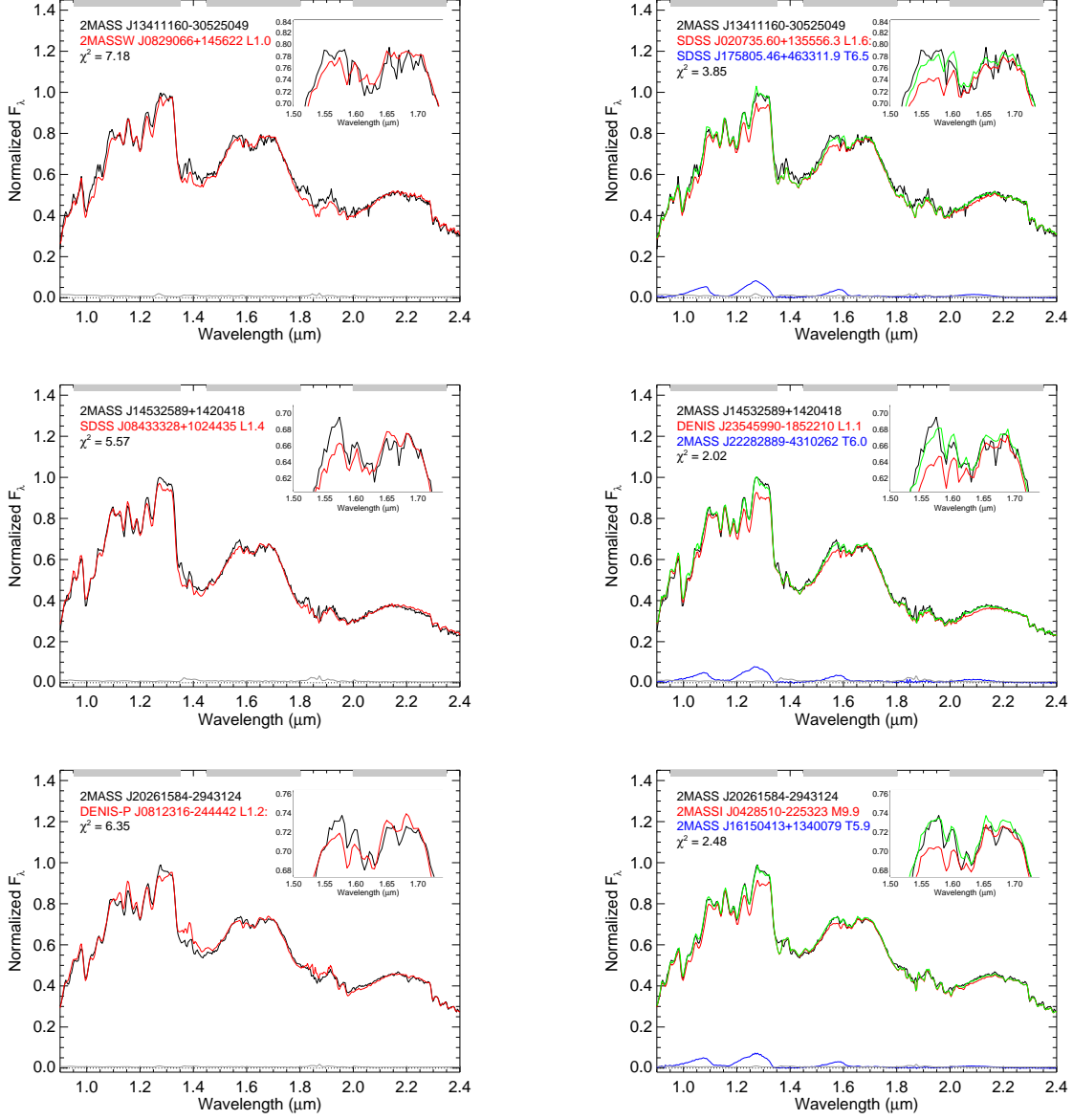


Fig. 4.— Continued.

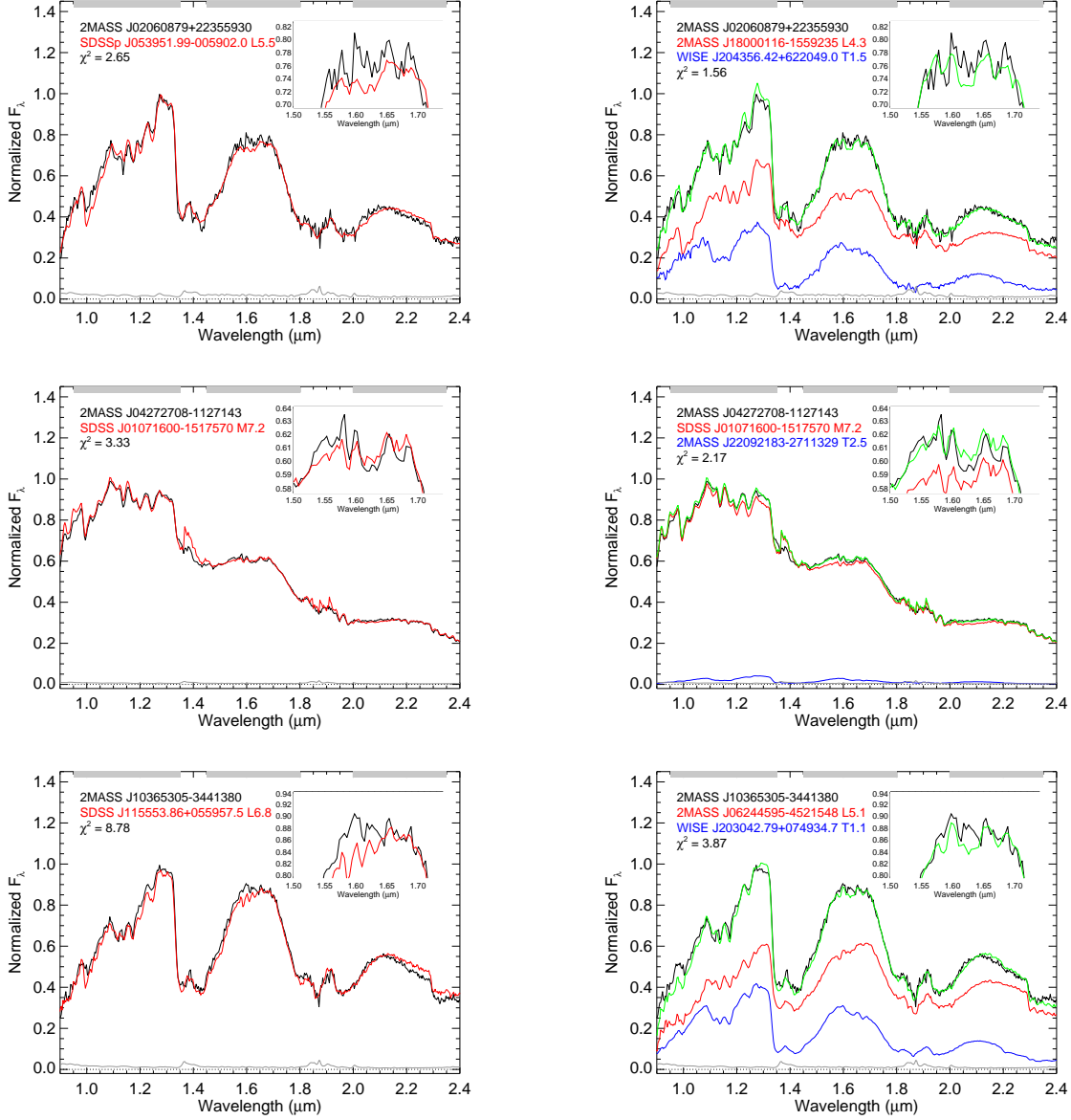


Fig. 5.— Best fits to single (left) and binary (right) templates for our weak candidates. Same color code as for Figure 4.

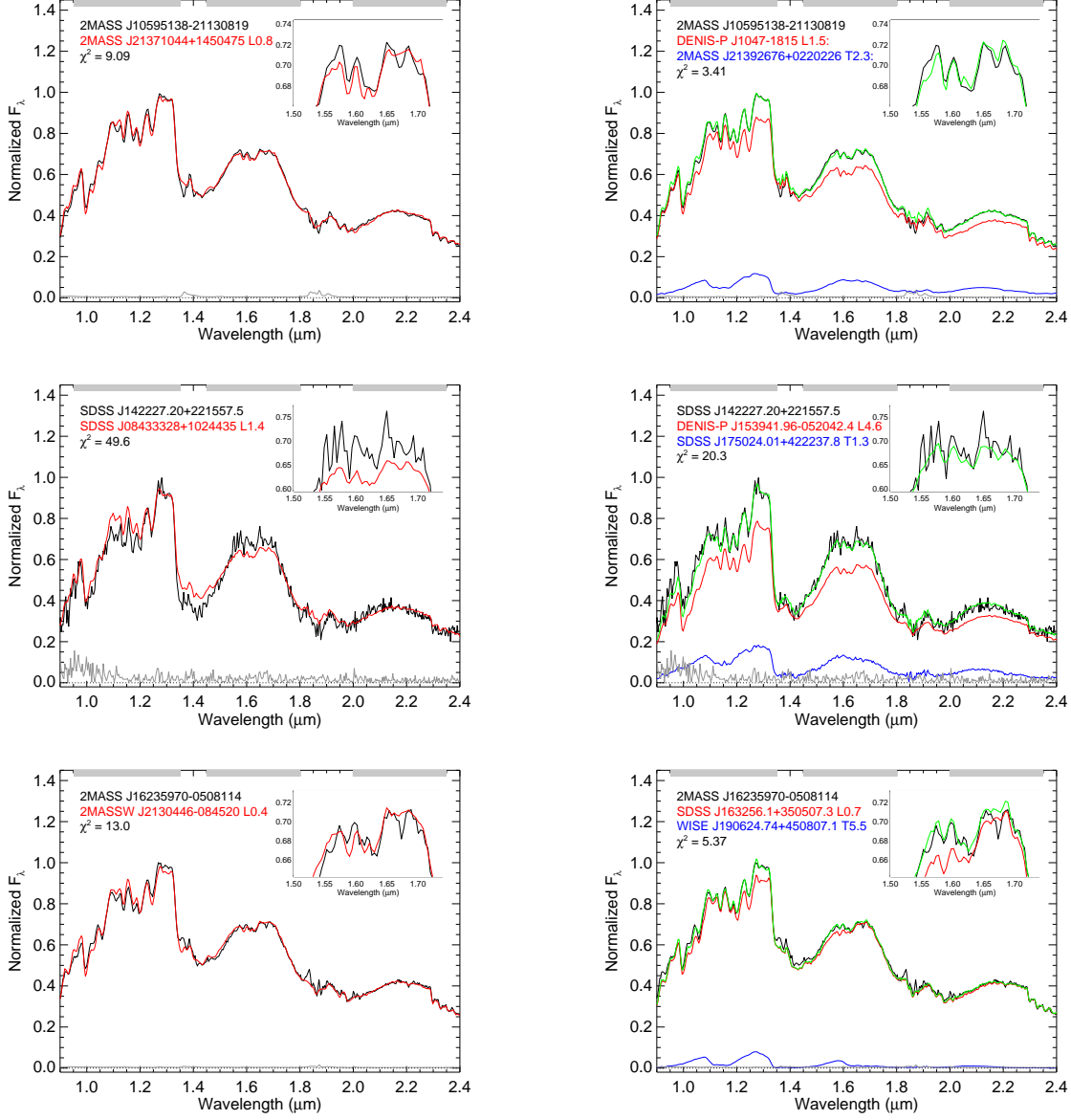


Fig. 5.— Continued.

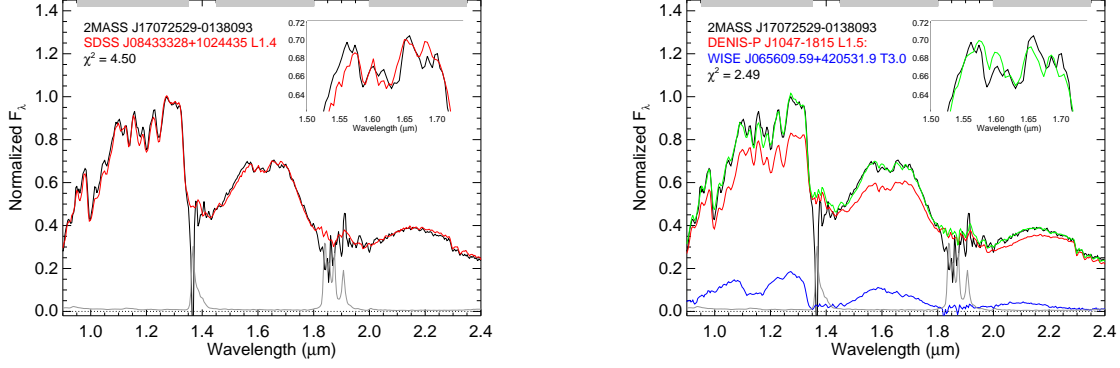


Fig. 5.— Continued.

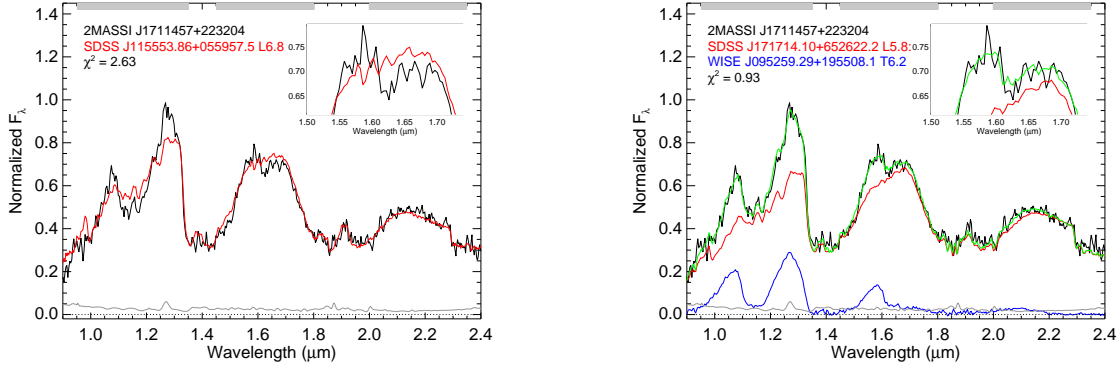


Fig. 6.— Best fits to single (left) and binary (right) templates for the only visual candidate not selected by indices. Same color code as for Figure 4.

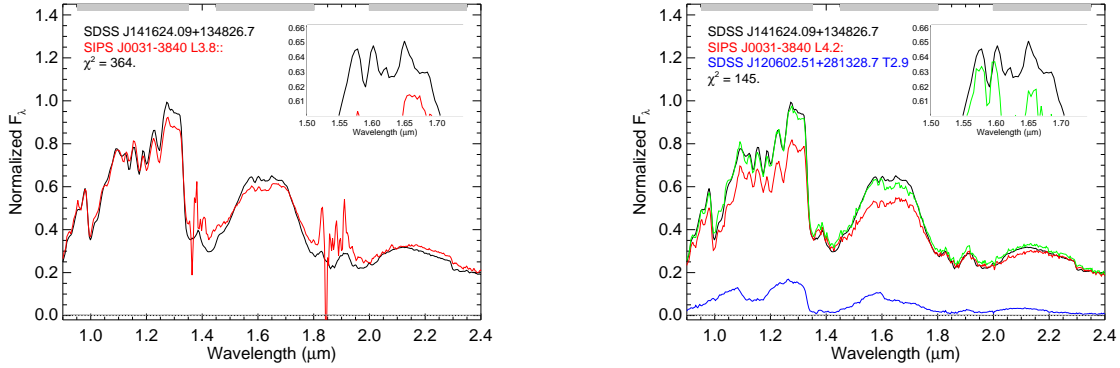


Fig. 7.— Example of best fits to the blue L dwarf SDSS J141624.09+134826.7.

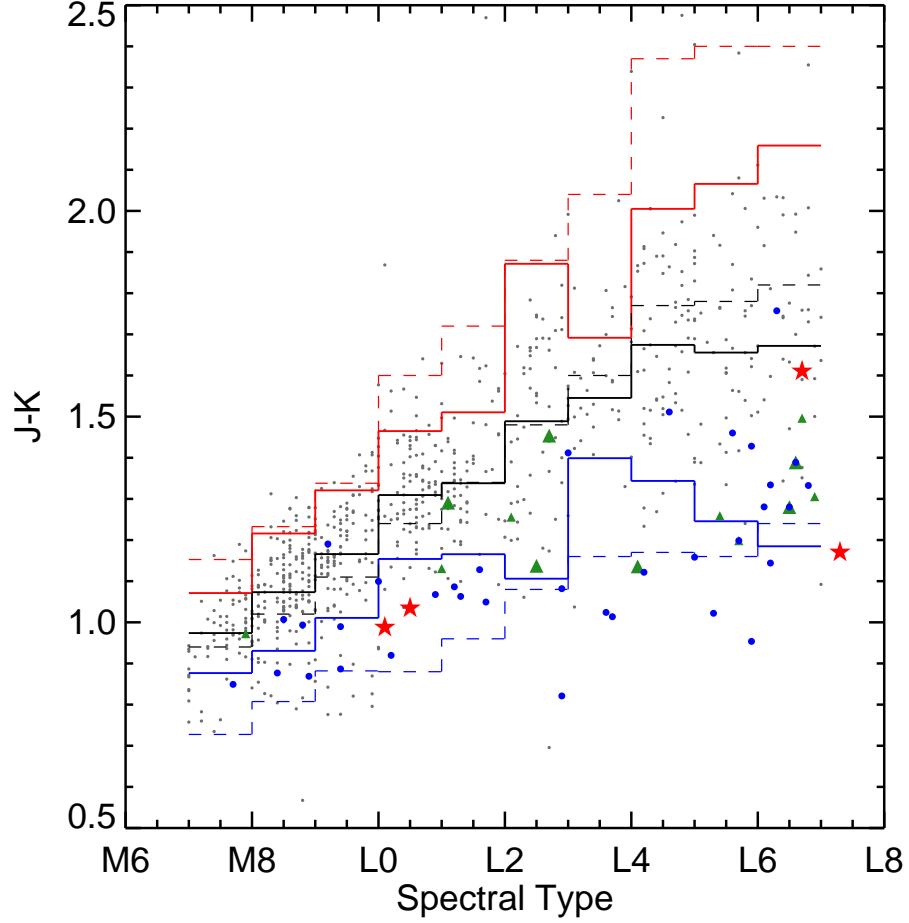


Fig. 8.— Comparison of spectrophotometric  $J-K_s$  colors of the “candidate” sample as a function of spectral type. The solid black line shows the median  $J-K$  colors from the sample, while the dashed black line represents the median  $J-K$  colors as calculated by West et al. (2011) and Schmidt et al. (2010) from samples of M and L dwarfs. The  $+2\sigma$  and  $-2\sigma$  boundaries are indicated in red and blue, respectively. The dashed lines indicate the  $+2\sigma$  and  $-2\sigma$  boundaries from West et al. (2011) and Schmidt et al. (2010). Outliers to these regions indicate unusually red and blue dwarfs as described by Faherty et al. (2009). Red stars indicate confirmed M/L+T binaries, while large and small green triangles are strong and weak binary candidates as selected by spectral indices. Blue circles represent unusually blue sources as listed in the literature.

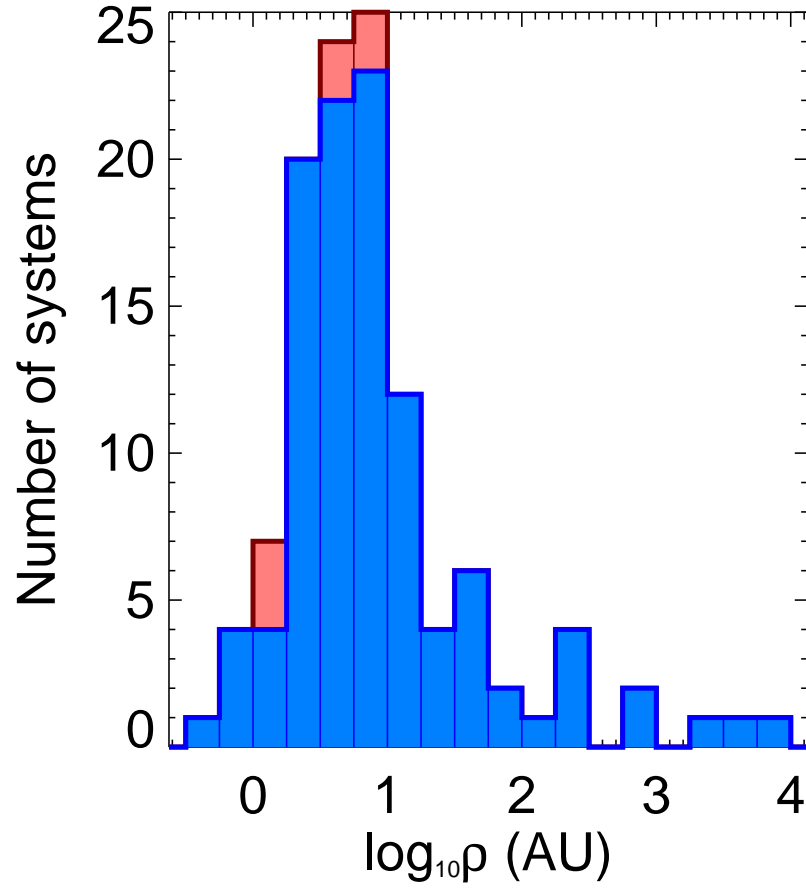


Fig. 9.— Projected separation ( $\rho$ ) distribution of 122 confirmed brown dwarf and VLM binary systems from the Very Low Mass Binaries Archive. Spectral binaries are shown in red. Binary systems with only upper limits in separation have been excluded.



Table 1. Compilation of all confirmed and candidate spectral binaries discovered to date.

| Name                                    | Spectral Type |          |          |           | J mag      | J-K <sub>s</sub> | $\Delta$ J           | Separation <sup>a</sup><br>(AU) | Confirmation <sup>b</sup><br>method | Ref.<br>SB; Conf. |
|---|---------------|----------|----------|-----------|------------|------------------|----------------------|---------------------------------|-------------------------------------|-------------------|
|   | Optical       | NIR      | Primary  | Secondary |            |                  |                      |                                 |                                     |                   |
| SDSS J000649.16-085246.3 <sup>*,†</sup> | M9            | ...      | M8.5±0.5 | T5±1      | 14.14±0.04 | 1.01±0.05        | 3.15±0.31            | 0.29±0.01                       | RV                                  | 2; 2              |
| ULAS J004757.41+154641.4                | ...           | T2.0±2.0 | L8.0     | T7.0      | 17.83±0.05 | 1.41±0.07        | ...                  | < 65                            |                                     | 22                |
| 2MASS J00521232+0012172                 | L5            | ...      | L4       | T3        | 16.36±0.11 | 0.90±0.19        | ...                  | < 49                            |                                     | 24                |
| SDSS J011912.22+240331.6                | ...           | T2       | T0±0.7   | T4±0.4    | 17.02±0.18 | < -0.02          | -0.42±0.19           | < 43                            |                                     | 21                |
| ULAS J020529.62+142114.0                | ...           | T1.0±0.5 | T1.0     | T3.0      | 17.99±0.04 | 1.06±0.07        | -                    | < 71                            |                                     | 22                |
| 2MASS J02060879+22355930                | ...           | L5.5     | L5.1±0.5 | T3.2±2.3  | 16.56±0.11 | 1.39±0.17        | 1.61±0.89            | ...                             |                                     | 26                |
| 2MASS J02361794+0048548                 | L6.5          | ...      | L5.0±0.6 | T1.9±1.1  | 16.10±0.08 | 1.43±0.12        | 1.05±0.48            | < 48                            |                                     | 26                |
| SDSS J024749.90-163112.6                | ...           | T2.0±1.5 | T0±0.2   | T7±0.3    | 17.19±0.18 | 1.57±0.27        | 0.68±0.10            | < 36                            |                                     | 21                |
| 2MASS J03202839-0446358 <sup>*,†</sup>  | M8:           | L1       | M8.5±0.3 | T5±0.9    | 12.13±0.03 | 1.13±0.04        | 3.5±0.2              | < 0.58                          | RV                                  | 5; 1              |
| SDSS J035104.37+481046.8                | ...           | T1.0±1.5 | L6.5±0.7 | T5±0.7    | 16.47±0.13 | 1.47±0.18        | 0.31±0.31            | < 34                            |                                     | 21                |
| DENIS-P J04272708-1127143               | ...           | dM7      | M7.4±0.2 | T5.1±1.5  | 13.74      | 0.99±0.14        | 4.13±0.62            | ...                             |                                     | 26                |
| 2MASS J05185995-2828372 <sup>†</sup>    | ...           | ...      | L6       | T4        | 15.98±0.10 | 1.82±0.12        | 0.13±0.19            | 1.80±0.50                       | DI                                  | 10; 7             |
| 2MASS J07354882+2720167                 | L1            | ...      | L1       | L4        | 16.94±0.13 | 1.28±0.21        | ...                  | < 112                           |                                     | 23                |
| SDSS J080531.84+481233.0 <sup>*,†</sup> | L4            | L9.5     | L4.5     | T5        | 14.73±0.04 | 1.46±0.05        | 1.50±0.09            | 0.9-2.3                         | AV                                  | 6; 11             |
| SDSS J090900.73+652527.2                | ...           | T1.5     | T1.5±0.5 | T2.5±0.3  | 16.03±0.09 | 0.86±0.17        | -0.12±0.10           | < 29                            |                                     | 21                |
| SDSS J092615.38+584720.9                | T4.5          | ...      | T3       | T6        | 16.77±0.14 | < 1.57           | 0.4±0.2 <sup>c</sup> | 2.6±0.5                         | DI                                  | 16; 7, 8          |
| SDSS J093113.23+280227.1                | L3            | ...      | L1.4±0.1 | T2.6±0.9  | 14.98±0.04 | 1.25±0.06        | 2.22±0.23            | < 37                            |                                     | 26                |
| 2MASS J09490860-1545485                 | ...           | T2       | T1±0.2   | T2±0.2    | 16.15±0.12 | 0.92±0.20        | -0.07±0.05           | < 25                            |                                     | 21                |
| 2MASS J10365305-3441380                 | L6            | ...      | L5.2±0.4 | T1.4±0.4  | 15.62±0.05 | 1.82±0.06        | 0.51±0.32            | < 30                            |                                     | 26                |
| SDSS J103931.35+325625.5                | ...           | T1       | L7±0.2   | T4±0.2    | 16.41±0.15 | 1.25±0.22        | 0.26±0.09            | < 34                            |                                     | 21                |
| 2MASS J10595138-2113082                 | L1            | ...      | L0.6±0.4 | T3.4±1.3  | 14.56±0.04 | 1.35±0.06        | 2.58±0.32            | <52.5                           |                                     | 26                |
| 2MASS J11061197+2754225 <sup>†</sup>    | ...           | T2.5     | T0±0.2   | T4.5±0.2  | 14.82±0.04 | 1.02±0.07        | -0.37±0.06           | <2.67                           | OL                                  | 4, 14; 15         |
| SDSS J120747.17+024424.8                | L8            | T0       | L6.5±0.7 | T2.5±0.5  | 15.58±0.07 | 1.59±0.09        | 0.48±0.28            | <17                             |                                     | 21                |
| 2MASS J12144089+6316434                 | ...           | T3.5     | T2       | T6        | 16.59±0.12 | 0.71±0.26        | ...                  | <24                             |                                     | 24                |
| 2MASS J13114227+3629235                 | L5pec         | ...      | L4.8±0.6 | T4.1±2.7  | 15.54±0.05 | 1.40±0.09        | 2.19±1.02            | < 27                            |                                     | 27                |
| 2MASS J13153094-2649513 <sup>*,†</sup>  | L5            | ...      | L3.5±2.5 | T7±0.6    | 15.07±0.05 | 1.63±0.07        | 3.03±0.03            | 6.60±0.90                       | DI                                  | 3; 3              |
| 2MASS J13243559+6358284                 | ...           | T2:      | L8±0.2   | T3.5±0.2  | 15.60±0.07 | 1.54±0.09        | -0.05±0.06           | < 23                            |                                     | 21, 2 4           |
| 2MASS J13411160-30525049                | L3            | ...      | L1.2±0.3 | T6.3±1.0  | 14.61±0.03 | 1.53±0.04        | 3.28±0.53            | < 39                            |                                     | 26                |
| SDSS J141530.05+572428.7                | ...           | T3±1     | L8±0.5   | T5±0.3    | 16.73±0.16 | < 1.19           | -0.13±0.20           | <29                             |                                     | 21                |
| SDSS J142227.20+221557.5                | L6.5          | ...      | L4.2±0.6 | T4.1±2.3  | 16.87±0.03 | 1.23±0.04        | 2.36±0.78            | < 43                            |                                     | 26                |
| 2MASS J14232186+6154005                 | L4            | ...      | L2       | L5        | 16.63±0.15 | 1.35±0.2         | ...                  | ...                             | ...                                 | 23                |
| SDSS J143553.25+112948.6                | ...           | T2±1     | L7.5±0.4 | T6±0.3    | 17.14±0.23 | < 0.23           | 0.41±0.12            | < 39                            |                                     | 21                |
| SDSS J143945.86+304220.6                | ...           | T2.5     | T1±0.2   | T5±0.6    | 17.22±0.23 | < 1.34           | 0.06±0.24            | < 45                            |                                     | 21                |
| 2MASS J14532589+1420418                 | L1            | ...      | L1.1±0.0 | T6.0±1.1  | 15.07±0.04 | 1.18±0.05        | 3.27±0.46            | < 72                            |                                     | 26                |
| SDSS J151114.66+060742.9 <sup>†</sup>   | -             | T0±2     | L5.5±0.8 | T5±0.4    | 16.02±0.08 | 1.47±0.13        | 0.54±0.32            | <21                             | OL                                  | 4; 12             |
| SDSS J151603.03+025928.9                | ...           | T0:      | L7.5±1.1 | T2.5±2.2  | 17.23±0.20 | 1.80±0.27        | 0.30±0.65            | <27                             |                                     | 21, 24            |
| WISE J16235970-0508114                  | ...           | L1       | L0.6±0.3 | T6.0±0.8  | 14.94±0.04 | 1.39±0.06        | 3.39±0.40            | ...                             |                                     | 26                |
| 2MASS J17072529-0138093                 | ...           | ...      | L0.7±0.5 | T4.3±2.0  | 14.29±0.03 | 1.22±0.04        | 2.87±0.75            | < 31                            |                                     | 26                |
| 2MASSI J17114573+2232044                | L6.5          | ...      | L1.5±0.6 | T2.5±1.0  | 17.09±0.18 | 2.36±0.20        | 1.20±0.40            | < 35                            |                                     | 21                |
| 2MASS J17310140+5310476                 | L6            | ...      | L5       | L8        | 16.37±0.11 | 1.52±0.18        | ...                  | <48                             |                                     | 23, 24            |

Table 1—Continued

| Name                                  | Spectral Type |          |          |           | J mag      | J-K <sub>s</sub> | $\Delta$ J | Separation <sup>a</sup><br>(AU)     | Confirmation <sup>b</sup><br>method | Ref.<br>SB; Conf. |
|---------------------------------------|---------------|----------|----------|-----------|------------|------------------|------------|-------------------------------------|-------------------------------------|-------------------|
|                                       | Optical       | NIR      | Primary  | Secondary |            |                  |            |                                     |                                     |                   |
| 2MASS J17373467+5953434               | L9            | ...      | L5       | T5        | 16.88±0.16 | 1.16±0.31        | ...        | < 50                                |                                     | 23                |
| 2MASS J20261584-2943124               | L1:           | ...      | L0.1±0.5 | T5.8±1.0  | 14.80±0.03 | 1.44±0.05        | 3.42±0.40  | <9.00                               | DI                                  | 13                |
| SDSS J205235.31-160929.8 <sup>†</sup> | ...           | T1±1     | L7.5±0.6 | T2±0.2    | 16.33±0.12 | 1.21±0.19        | 0.04±0.18  | 3.20±0.50                           | DI                                  | 4; 17             |
| 2MASS J21265916+7617440               | L7            | T0       | L7       | T3.5      | 14.34±0.03 | 1.18±0.05        | ...        | ...                                 |                                     | 28                |
| 2MASS J21392676+0220226               | ...           | T1.5     | L8.5±0.7 | T3.5±1.0  | 15.26±0.05 | 1.68±0.07        | -0.14±0.21 | < 14                                |                                     | 21                |
| ULAS J222958.30+010217.2              | ...           | T3.0±0.5 | T1.0     | T5.0      | 17.89±0.04 | 0.67±0.10        | ...        | < 62                                |                                     | 22                |
| ULAS J223348.82+002214.0              | ...           | T0.0±0.5 | L5.0     | T4.0      | 18.07±0.05 | 1.43±0.07        | ...        | < 90                                |                                     | 22                |
| ULAS J235618.01+075420.4              | ...           | T0.0±1.0 | L7.0     | T7.0      | 18.09±0.05 | 1.87±0.06        | ...        | < 58                                |                                     | 22                |
| ULAS J232315.39+071931.0              | ...           | T2.0±0.5 | T0.0     | T2.0      | 17.30±0.02 | 1.01±0.04        | ...        | < 49                                |                                     | 22                |
| Kelu-1A                               | L3pec±1.5     | L2.0±1.0 | L0.5±0.5 | T7.5±1    | 13.88±0.03 | 1.57±0.04        | ...        | 6.4 <sup>+2.4</sup> <sub>-1.3</sub> |                                     | 25                |

\*Used as M+T binary benchmark.

<sup>†</sup>Spectral binaries with confirmed separations. See figure 6.

<sup>a</sup>Upper limits based on SDSS angular resolution (1" - York et al. 2000) and distance reported or estimated from absolute magnitudes (Looper et al. 2008a).

<sup>b</sup>RV = Radial Velocity, DI = Direct Imaging, AV = Astrometric Variability, OL = Overluminous.

<sup>c</sup>Estimated from F110W filter (Burgasser et al. 2006b).

References. — (1) Blake et al. (2008); (2) Burgasser et al. (2012); (3) Burgasser et al. (2011b); (4) Burgasser et al. (2010a); (5) Burgasser et al. (2008a); (6) Burgasser (2007b); (7) Burgasser et al. (2006b); (8) Carson et al. (2011); (9) Chiu et al. (2006); (10) Cruz et al. (2004); (11) Dupuy & Liu (2012); (12) Faherty et al. (2012); (13) Gelino & Burgasser (2010); (14) Looper et al. (2008a); (15) Manjavacas et al. (2013); (16) Metchev et al. (2008); (17) Stumpf et al. (2011); (21) Burgasser et al. (2010a); (22) Day-Jones et al. (2013); (23) Geißler et al. (2011); (24) Metchev et al. (2008); (25) Stumpf et al. (2008); (26) This paper; (27) Kirkpatrick et al. (2011); (28) Kirkpatrick et al. (2010).

Table 2. New SpeX Observations of M7-L6 Dwarfs

| Source                    | Designation        | Spectral Type |      |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR  | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASS J0000286-124515     | J00002867-1245153  | M8.5          | ...  | M9.2              | 13.20 | 1.23      | 2013 Aug 14 | 120                     | 44; 44           |
| LEHPM 1-162               | J00054768-2157176  | M8.5          | M8   | M8.7              | 13.27 | 1.07      | 2006 Sep 03 | 120                     | 32; 75           |
| 2MASS J0006205-172051     | J00062050-1720506  | L2.5          | ...  | L3.0              | 15.66 | 1.65      | 2008 Sep 08 | 120                     | 25; 25           |
| SDSS J000632.60+140606.4  | J00063260+1406064  | L1            | ...  | L0.4              | 15.85 | 0.79      | 2009 Jun 30 | 120                     | 48; 48           |
| SDSS J000646.81+151225.8  | J00064681+1512258  | L4::          | ...  | L4.3              | 16.22 | 1.41      | 2013 Sep 03 | 120                     | 62; 62           |
| 2MASS J0007078-245804     | J00070787-2458042  | M7            | ...  | M7.7              | 13.12 | 1.05      | 2013 Oct 23 | 120                     | 44; 44           |
| 2MASS J00100009-2031122   | J00100009-2031122  | L0            | ...  | M8.8:             | 14.13 | 1.25      | 2008 Jul 14 | 120                     | 44; 44           |
| 2MASS J0013578-223520     | J00135779-2235200  | L4            | ...  | L5.7              | 15.78 | 1.74      | 2009 Nov 04 | 120                     | 25; 25           |
| 2MASSW J0015447+351603    | J00154476+3516026  | L2            | ...  | L1.0              | 13.88 | 1.61      | 2008 Sep 08 | 120                     | 13; 13           |
| SDSS J001608.44-004302.3  | J00160843-00430209 | ...           | L5.5 | L4.3              | 16.33 | 1.78      | 2013 Sep 03 | 120                     | 34; 34           |
| SDSS J001637.62-103911.2  | J00163762-1039112  | L0            | ...  | M8.9              | 15.46 | 0.92      | 2009 Nov 04 | 120                     | 48; 48           |
| SDSS J001911.65+003017.8  | J00191165+0030176  | L1            | ...  | L0.4              | 14.92 | 1.35      | 2009 Nov 07 | 120                     | 20; 20           |
| DENIS-P J0020.9-4414      | J00205982-4414340  | M8V           | ...  | M9.4              | 14.90 | 1.19      | 2007 Nov 10 | 120                     | 6; 6             |
| LEHPM 1-494B              | J00210589-4244433  | M9.5          | ...  | L0.6:             | 13.52 | 1.22      | 2006 Aug 28 | 120                     | 6; 15            |
| SDSS J00220934-0110397    | J00220934-0110397  | L0            | ...  | M8.9              | 15.82 | 1.12      | 2012 Sep 27 | 120                     | 60; 60           |
| BRI 0021-0214             | J00242514-0158166  | M9.5          | ...  | L0.6              | 11.99 | 1.45      | 2007 Jul 04 | 120                     | 80; 44           |
|                           |                    |               |      |                   |       |           | 2008 Jul 14 | 120                     | 80; 44           |
| LHS 1074                  | J00255117-0748069  | sdM6          | ...  | M7.9              | 14.68 | 0.81      | 2004 Sep 08 | 120                     | ... ; 39         |
| LEHPM 1-606               | J00271049-1813083  | ...           | M8   | M7.5              | 13.45 | 1.02      | 2006 Sep 03 | 120                     | 32; 75           |
| 2MASS J0028394+150141     | J00283943+1501418  | L4.5          | L3   | L6.1:             | 16.51 | 1.95      | 2009 Dec 07 | 120                     | 13; 13, 34       |
| 2MASS J00285545-1927165   | J00285545-1927165  | L0:           | ...  | L0.7              | 14.19 | 1.35      | 2009 Nov 04 | 120                     | 49; 49           |
| 2MASSW J0030438+313932    | J00304384+3139321  | L2            | ...  | L3.2              | 15.48 | 1.45      | 2008 Sep 08 | 120                     | 11; 11           |
| SIPS J0031-3840           | J00311925-3840356  | L2.5          | L2   | L1.2              | 14.10 | 1.18      | 2006 Aug 28 | 120                     | 36; 59, 36       |
| 2MASS J00320509+0219017   | J00320509+0219017  | L1.5          | M9   | L0.4              | 14.32 | 1.52      | 2009 Jun 30 | 120                     | 49; 49, 30       |
|                           |                    |               |      |                   |       |           | 2009 Nov 07 | 120                     | 49; 49, 30       |
| 2MASS J0032431-223727     | J00324308-2237272  | L1            | ...  | M9.7:             | 15.39 | 1.43      | 2009 Dec 07 | 120                     | 25; 25           |
| EROS-MP J0032-4405        | J00325584-4405058  | L0gamma       | ...  | L0.5              | 14.78 | 1.51      | 2008 Sep 07 | 120                     | 8; 56            |
| 2MASS J0034568-070601     | J00345684-0706013  | L3            | ...  | L4.3              | 15.53 | 1.59      | 2009 Nov 07 | 120                     | 25; 25           |
| SDSS J003843.99+134339.5  | J00384397+13433950 | L1            | ...  | L0.6              | 15.91 | 1.15      | 2012 Sep 27 | 120                     | 20; 20           |
| SDSS J004154.54+134135.5  | J00415453+1341351  | L0            | ...  | L0.6              | 14.45 | 1.22      | 2009 Jan 24 | 120                     | 20; 20           |
|                           |                    |               |      |                   |       |           | 2009 Nov 08 | 120                     | 20; 20           |
| LHS 1135                  | J00433134+2054316  | sdM6.5        | ...  | M7.0              | 13.95 | 0.81      | 2004 Jul 24 | 120                     | ... ; 39         |
| 2MASSW J0045214+163445    | J00452143+1634446  | L2beta        | L3.5 | L1.3::            | 13.06 | 1.69      | 2007 Sep 16 | 120                     | 30; 56, 30       |
| 2MASS J00464841+0715177   | J00464841+0715177  | L0::          | M9   | M9.5:             | 13.89 | 1.34      | 2008 Jul 13 | 120                     | 30; 49, 30       |
| SIPS J0050-1538           | J00502444-1538184  | L1:           | ...  | L0.5              | 13.78 | 1.13      | 2008 Sep 08 | 120                     | 36; 44           |
| SDSSp J005406.55-003101.8 | J00540654-00310180 | L1            | ...  | L2.2              | 15.73 | 1.35      | 2012 Sep 25 | 120                     | 19; 20           |
| 2MASS J00550460-3052000   | J00550460-3052000  | M8:           | ...  | M7.2              | 13.03 | 1.12      | 2012 Dec 27 | 120                     | ... ; ...        |
| LHS 1166                  | J00554418+2506235  | sdM6.5        | ...  | M7.2              | 14.26 | 0.69      | 2004 Sep 07 | 120                     | ... ; 39         |
| SDSS J00570556-0846241    | J00570556-0846241  | L0            | ...  | M9.3              | 15.70 | 1.34      | 2012 Sep 25 | 120                     | 60; 60           |
| 2MASSW J0058425-065123    | J00584253-0651239  | L0            | ...  | L0.0              | 14.31 | 1.41      | 2008 Jul 14 | 120                     | 13; 13           |

Table 2—Continued

| Source                    | Designation        | Spectral Type |          |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|----------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR      | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| LHS 132                   | J0102510-373743    | M8            | ...      | M8.1              | 11.13 | 1.06      | 2008 Sep 07 | 120                     | ... ; ...        |
| SDSS J010311.51-004417.0  | J01031151-0044170  | M9.5          | ...      | M8.5              | 14.29 | 1.12      | 2013 Oct 29 | 120                     | 62; 62           |
| 2MASS J0103320+193536     | J01033203+1935361  | L6            | ...      | L5.4              | 16.29 | 2.14      | 2006 Sep 02 | 120                     | 13; 13           |
| 2MASS J0104075-005328     | J01040750-0053283  | L4.5          | ...      | L5.8:             | 16.53 | 1.20      | 2009 Nov 07 | 120                     | 29; 81           |
| SDSS J010637.33+151855.0  | J01063733+1518550  | M8.5          | M8 pec   | M9.2              | 14.36 | 0.93      | 2013 Sep 03 | 120                     | 62; 62, 66       |
| SDSS J01071600-1517570    | J01071600-1517570  | M7            | ...      | M7.2              | 13.34 | 1.06      | 2012 Dec 27 | 120                     | ... ; ...        |
| SDSSp J010752.33+004156.1 | J01075242+0041563  | L8            | L5.5     | L6.6              | 15.82 | 2.12      | 2005 Oct 19 | 120                     | 21; 20, 34       |
| SDSS J01084048+1347392    | J01084048+1347392  | L0            | ...      | M9.3              | ...   | ...       | 2012 Sep 27 | 120                     | 60; 60           |
| 2MASS J01165457-1357342   | J01165457-1357342  | M9            | ...      | M8.8              | 14.21 | 1.24      | 2009 Nov 08 | 120                     | 49; 49           |
| 2MASS J01170586+1752568   | J01170586+1752568  | M9            | M8       | M8.6              | 14.14 | 1.20      | 2009 Nov 04 | 120                     | 61; 61           |
| SSSPM J0124-4240          | J01235905-4240073  | M8            | L2.5     | M8.4              | 13.15 | 1.12      | 2008 Sep 07 | 120                     | 37; 49, 37       |
| 2MASS J0125369-343505     | J01253689-3435049  | L2            | ...      | L1.2              | 15.52 | 1.62      | 2008 Sep 07 | 120                     | 25; 25           |
| 2MASS J01273917+2805536   | J01273917+2805536  | M8.5          | ...      | M9.3              | 14.04 | 1.18      | 2013 Aug 14 | 120                     | ... ; ...        |
| SDSS J012743.51+135420.9  | J01274352+13542099 | L5            | L6+/-1   | L5.5              | 16.83 | 1.40      | 2012 Sep 25 | 120                     | 20; 20, 34       |
| 2MASSW J0129122+351758    | J01291221+3517580  | L4            | ...      | L4.7              | 16.78 | 2.08      | 2009 Nov 07 | 120                     | 11; 11           |
| 2MASS J01335299+0033017   | J01335299+0033017  | M9:           | ...      | M9.1              | 15.84 | 1.21      | 2009 Jan 24 | 120                     | 62; 62           |
| NLT 5282                  | J0134592-090442    | esdM9.5?      | ...      | M8.8              | 15.25 | 0.49      | 2008 Jul 14 | 120                     | ... ; ...        |
| 2MASSW J0135358+120522    | J01353586+1205216  | L1.5          | ...      | L0.6              | 14.41 | 1.49      | 2009 Nov 04 | 120                     | 13; 13           |
| 2MASSW J0141032+180450    | J01410321+1804502  | L1            | L4.5     | L0.8              | 13.88 | 1.38      | 2008 Sep 07 | 120                     | 30; 44, 30       |
| 2MASS J01460119-4545263   | J01460119-4545263  | M9            | ...      | M9.5              | 14.40 | 1.36      | 2008 Oct 12 | 120                     | 49; 49           |
|                           |                    |               |          |                   |       |           | 2009 Dec 07 | 120                     | 49; 49           |
| 2MASSW J0147334+345311    | J01473344+3453112  | L0.5          | ...      | L1.0              | 14.95 | 1.37      | 2008 Sep 08 | 120                     | 11; 11           |
| 2MASS J01490895+2956131   | J01490895+2956131  | M9.5          | ...      | M9.7              | 13.45 | 1.47      | 2008 Sep 07 | 120                     | ... ; ...        |
| SDSS J01535423+1404528    | J01535423+1404528  | L0            | ...      | M9.0              | 15.21 | 1.25      | 2012 Sep 27 | 120                     | 60; 60           |
| LEHPM 2153                | J02042212-3632308  | M8:           | ...      | M8.1              | 13.27 | 1.08      | 2013 Dec 05 | 120                     | 49; 49           |
| SDSS J020608.97+223559.2  | J02060879+22355930 | ...           | L5.5     | L6.9:             | 16.56 | 1.39      | 2013 Dec 05 | 120                     | 40; 40           |
| DENIS J02065660-0735190   | J02065660-0735190  | M8.5          | ...      | M8.5              | 14.34 | 1.35      | 2013 Aug 14 | 120                     | 59; 59           |
| SDSS J020735.60+135556.3  | J02073556+13555639 | L3            | L3+/-1.5 | L0.6              | 15.46 | 1.65      | 2012 Sep 27 | 120                     | 20; 20, 34       |
| 2MASSW J0208549+250048    | J02085498+25004880 | L5            | ...      | L5.9              | 16.21 | 1.80      | 2012 Sep 25 | 120                     | 13; 13           |
| 2MASS J0218291-313322     | J02182913-3133230  | L3            | ...      | L3.8              | 14.73 | 1.57      | 2009 Nov 08 | 120                     | 27; 27           |
| 2MASS J02192196+0506306   | J02192196+0506306  | L1:           | L1       | L3.0              | 14.97 | 1.49      | 2008 Sep 23 | 120                     | ... ; 55         |
| SSSPM J0219-1939          | J02192807-1938416  | L1            | L2.5     | L0.6              | 14.11 | 1.20      | 2008 Sep 08 | 120                     | 83; 37           |
| 2MASS J0224367+253704     | J02243669+25370419 | L2            | ...      | L2.3              | 16.58 | 1.89      | 2012 Sep 27 | 120                     | 13; 13           |
| 2MASS J02284243+1639329   | J02284243+16393299 | L0:           | ...      | M8.7              | 13.17 | 1.35      | 2012 Oct 27 | 120                     | 49; 49           |
| 2MASS J02301551+2704061   | J02301551+2704061  | L0:           | ...      | M9.4              | 14.29 | 1.31      | 2008 Sep 07 | 120                     | 44; 44           |
| DENIS J02304500-0953050   | J02304500-0953050  | L0            | ...      | L0.9              | 14.68 | 1.69      | 2013 Aug 14 | 120                     | 59; 59           |
| SDSS J023547.56-084919.8  | J02354755-08491980 | L2            | ...      | L2.0:             | 15.57 | 1.38      | 2012 Sep 27 | 120                     | 20; 20           |
| SDSSp J023617.93+004855.0 | J02361793+00485479 | L6            | L6.5     | L6.6:             | 16.10 | 1.43      | 2012 Sep 25 | 120                     | 21; 20, 34       |
| 2MASS J0239424-173547     | J02394245-1735471  | L0            | ...      | M9.0              | 14.29 | 1.25      | 2009 Nov 08 | 120                     | 27; 27           |
| 2MASS J0241536-124106     | J02415367-1241069  | L2:           | ...      | L1.9              | 15.61 | 1.67      | 2008 Sep 08 | 120                     | 27; 27           |

Table 2—Continued

| Source                    | Designation        | Spectral Type |        |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|--------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR    | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASSW J0242435+160739    | J02424354+16073920 | L1.5          | ...    | L1.7              | 15.78 | 1.43      | 2012 Oct 27 | 120                     | 11; 11           |
| SDSS J02511323+00473631   | J02511323+00473631 | M8            | ...    | M8.2              | 13.77 | 1.09      | 2013 Sep 03 | 120                     | 48; 48           |
| 2MASS J02522628+0056220   | J02522628+0056220  | M8            | ...    | M8.3              | 13.13 | 1.16      | 2012 Dec 27 | 120                     | ... ; ...        |
| SDSS J02540582-1934523    | J02540582-1934523  | M9            | M9     | M8.1              | 13.08 | 1.17      | 2009 Jan 25 | 120                     | 49; 85           |
|                           |                    |               |        |                   |       |           | 2012 Dec 27 | 120                     | 49; 85           |
| 2MASS J02594471+2254443   | J02594471+2254443  | M9            | ...    | M9.5              | 14.11 | 1.25      | 2009 Dec 07 | 120                     | 49; 49           |
| 2MASSI J0302012+135814    | J03020121+13581419 | L3            | ...    | L2.7:             | 16.53 | 1.90      | 2005 Oct 19 | 120                     | 13; 13           |
|                           |                    |               |        |                   |       |           | 2012 Sep 27 | 120                     | 13; 13           |
| LEHPM 1-3070              | J03061185-3647417  | M8            | L0     | M8.7              | 11.69 | 1.06      | 2006 Sep 03 | 120                     | 32; 37           |
| 2MASSW J0306268+154514    | J03062684+15451370 | L6:           | ...    | L6.0:             | 17.11 | 1.97      | 2012 Sep 25 | 120                     | 13; 13           |
| SDSS J03083243-08105138   | J03083243-08105138 | M8            | ...    | M7.6              | 14.98 | 0.89      | 2013 Sep 03 | 120                     | 48; 48           |
| 2MASSW J0309088-194938    | J03090888-19493870 | L4.5          | ...    | L4.9              | 15.75 | 1.69      | 2012 Sep 25 | 120                     | 13; 13           |
| 2MASS J03101401-2756452   | J03101401-2756452  | L5            | ...    | L6.5              | 15.80 | 1.84      | 2009 Nov 08 | 120                     | 44; 44           |
| 2MASS J03140344+1603056   | J03140344+16030560 | L0            | ...    | M9.4              | 12.53 | 1.29      | 2012 Sep 25 | 120                     | 49; 49           |
| 2MASSI J0316451-284852    | J03164511-28485209 | L0:           | ...    | L1.0              | 14.57 | 1.46      | 2013 Dec 05 | 120                     | 27; 27           |
| 2MASS J03201710-1026120   | J03201710-1026120  | M8            | ...    | M7.6              | 13.87 | 1.15      | 2013 Aug 14 | 120                     | 44; 44           |
| 2MASS J03250136+2253039   | J03250136+22530390 | L3            | ...    | L3.3              | 15.43 | 1.65      | 2013 Sep 03 | 120                     | 44; 44           |
| 2MASSW J0326137+295015    | J03261367+2950152  | L3.5          | ...    | L4.6              | 15.48 | 1.65      | 2009 Dec 07 | 120                     | 11; 11           |
| 2MASS J03264453+1919309   | J03264453+1919309  | M8.5          | ...    | M8.6              | 13.12 | ...       | 2012 Sep 25 | 120                     | 49; 49           |
| SDSSp J032817.38+003257.2 | J03281737+00325719 | L3            | ...    | L2.5:             | 15.99 | 1.83      | 2012 Sep 27 | 120                     | 19; 20           |
| LSPM J0330+3504B          | J03301720+3505001  | ...           | d/sdM7 | M8.6              | 16.00 | 0.68      | 2005 Oct 17 | 120                     | ... ; 75         |
|                           |                    |               |        |                   |       |           | 2005 Dec 31 | 120                     | ... ; 75         |
| SDSSp J033035.13-002534.5 | J03303511-0025346  | L4            | ...    | L6.5              | 15.31 | 1.47      | 2009 Nov 04 | 120                     | 12; 20           |
| LEHPM 1-3365              | J03303847-2348463  | ...           | esdM7  | M8.8              | 15.80 | 0.86      | 2004 Sep 09 | 120                     | 32; 75           |
| 2MASS J03320043-2317496   | J03320043-2317496  | M8            | ...    | M8.4              | 13.64 | 1.10      | 2013 Oct 29 | 120                     | 49; 49           |
| 2MASS J03335134+0014068   | J03335134+0014068  | sdL           | ...    | M7.6              | 16.43 | -0.35     | 2013 Dec 05 | 120                     | 62; 62           |
| LEHPM 1-3396              | J03340904-4953382  | ...           | M8     | M9.4              | 11.38 | 0.98      | 2004 Sep 06 | 120                     | 32; 75           |
| 2MASS J03350236+2342407   | J03350236+2342407  | M8.5          | ...    | M7.4              | 12.25 | 0.99      | 2013 Dec 05 | 120                     | 14; 67           |
| 2MASS J03354535+0658058   | J03354535+0658058  | M8            | ...    | M8.0              | 13.41 | 1.15      | 2012 Oct 27 | 120                     | 49; 49           |
| 2MASSW J0337036-175807    | J03370359-1758079  | L4.5          | ...    | L6.0:             | 15.62 | 2.04      | 2009 Nov 08 | 120                     | 13; 13           |
| 2MASS J03395284+2457270   | J03395284+2457270  | M8            | ...    | M7.7              | 12.84 | 1.10      | 2012 Dec 27 | 120                     | ... ; ...        |
| SDSS J03440891+0111249    | J03440891+0111249  | L1            | ...    | L2.9:             | 14.74 | 1.22      | 2012 Oct 27 | 120                     | 60; 60           |
| SDSS J03510002-00524587   | J03510002-00524587 | M8            | ...    | M7.3              | 11.30 | 1.07      | 2012 Oct 27 | 120                     | 48; 48           |
| 2MASS J03521086+0210479   | J03521086+02104797 | M9            | L0+/-1 | M8.6              | 13.08 | 1.12      | 2012 Oct 27 | 120                     | 47; 49, 47       |
| SDSS J035308.54+103056.0  | J03530854+1030560  | L1            | ...    | L0.9              | 15.45 | 1.27      | 2013 Oct 29 | 120                     | 60; 60           |
| 2MASS J03540135+2316330   | J03540135+2316330  | M8            | ...    | M7.9              | 13.12 | 1.13      | 2012 Dec 27 | 120                     | ... ; ...        |
| LEHPM 2-471               | J03551067-1858173  | ...           | M7     | M7.6              | 13.81 | 0.93      | 2006 Sep 03 | 120                     | 32; 75           |
| 2MASS J0355201+143929     | J0355201+143929    | M8            | ...    | M8.8              | 13.81 | 1.11      | 2013 Oct 29 | 120                     | 44; 44           |
| 2MASS J03552337+1133437   | J03552337+1133437  | L5gamma       | ...    | L4.8::            | 14.05 | 2.52      | 2009 Dec 07 | 120                     | 49; 56           |
| 2MASSW J0355419+225702    | J03554190+22570159 | L3            | ...    | L2.9:             | 16.11 | 1.83      | 2012 Sep 27 | 120                     | 11; 11           |

Table 2—Continued

| Source                    | Designation        | Spectral Type |       |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|-------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR   | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| DENIS-P J035729.6-441730  | J03572695-4417305  | L0beta        | ...   | L0.6:             | 14.37 | 1.46      | 2007 Sep 16 | 120                     | 38; 56           |
| 2MASS J04012977-4050448   | J04012977-40504488 | L0:           | ...   | L0.0              | 14.53 | 1.36      | 2012 Dec 27 | 120                     | 49; 49           |
| LSPM J0402+1730           | J04024315+1730136  | ...           | sdM7  | M7.0              | 15.59 | 0.56      | 2005 Oct 17 | 120                     | ... ; 75         |
|                           |                    |               |       |                   |       |           | 2005 Dec 31 | 120                     | ... ; 75         |
| 2MASS J04070752+1546457   | J04070752+1546457  | L3.5          | ...   | L3.9              | 15.48 | 1.92      | 2009 Dec 07 | 120                     | 49; 49           |
| 2MASS J0407089-234829     | J0407089-234829    | M8:           | ...   | M8.5              | 13.77 | 1.15      | 2013 Oct 29 | 120                     | 44; 44           |
| 2MASS J04081032+0742494   | J04081032+0742494  | M8            | ...   | M8.1              | 13.59 | 1.17      | 2013 Dec 05 | 120                     | 49; 49           |
| 2MASSI J0408290-145033    | J04082905-1450334  | L2            | L4.5  | L1.3              | 14.22 | 1.40      | 2009 Nov 04 | 120                     | 30; 27, 30       |
| 2MASSI J0409095+210439    | J04090950+2104393  | L3            | ...   | L3.4              | 15.51 | 1.66      | 2009 Dec 07 | 120                     | 13; 13           |
| 2MASS J0417474-212919     | J0417474-212919    | M8            | ...   | M8.3              | 13.85 | 1.18      | 2013 Oct 29 | 120                     | 44; 44           |
| SDSS J04270723+0859027    | J04270723+0859027  | M8            | ...   | M8.8              | 12.92 | 1.19      | 2012 Dec 27 | 120                     | ... ; ...        |
| DENIS J0427270-112713     | J04272708-1127143  | M7            | ...   | M7.9              | 13.74 | 1.07      | 2013 Dec 05 | 120                     | 59; 59           |
| 2MASSI J0428510-225323    | J04285095-22532270 | L0.5          | ...   | M9.9              | 13.51 | 1.39      | 2012 Sep 25 | 120                     | 25; 25           |
| LP 655-23B                | J04305157-0849007  | M8            | ...   | M8.5              | 12.90 | 1.12      | 2013 Dec 05 | 120                     | 28; 46           |
| LP 775-31                 | J0435161-160657    | ...           | M7    | M8.0              | 10.41 | 1.05      | 2004 Sep 07 | 120                     | ... ; ...        |
| 2MASS J04362054-4218523   | J04362054-42185236 | L0:           | ...   | L0.4              | 14.49 | 1.35      | 2012 Dec 27 | 120                     | 49; 49           |
| 2MASSI J0443058-320209    | J04430581-32020899 | L5            | ...   | L6.4:             | 15.27 | 1.40      | 2012 Sep 27 | 120                     | 25; 25           |
| SDSS J044337.61+000205.1  | J04433761+0002051  | M9            | ...   | M9.0              | 12.51 | 1.29      | 2013 Dec 05 | 120                     | 20; 44           |
| 2MASS 04441479+0543573    | J04441479+0543573  | M8            | ...   | M7.9              | 13.67 | 1.15      | 2013 Dec 05 | 120                     | 49; 49           |
| 2MASSI J0451009-340214    | J04510092-34021500 | L0.5          | ...   | L0.6              | 13.54 | 1.25      | 2012 Sep 27 | 120                     | 27; 27           |
| 2MASSI J0453264-175154    | J04532647-1751543  | L3:           | ...   | L3.1              | 15.14 | 1.68      | 2009 Nov 04 | 120                     | 27; 27           |
| 2MASS J05002100+0330501   | J05002099+03305010 | L4            | ...   | L4.1              | 13.67 | 1.61      | 2012 Dec 27 | 120                     | 49; 49           |
| 2MASSI J0502134+144236    | J05021345+1442367  | L0            | ...   | M8.9              | 14.27 | 1.32      | 2013 Dec 05 | 120                     | 60; 55           |
| 2MASS J05120636-2949540   | J05120636-29495400 | L4.5          | ...   | L5.7::            | 15.46 | 2.18      | 2013 Oct 29 | 120                     | 27; 52           |
| 2MASS J05170548-4154413   | J05170548-4154413  | M9            | ...   | M8.8              | 13.46 | 1.19      | 2012 Dec 27 | 120                     | ... ; ...        |
| LEHPM 2-183               | J05173729-3348593  | M8            | M9    | M9.4              | 12.00 | 1.17      | 2004 Sep 06 | 120                     | 32; 27, 75       |
| 2MASS J05184616-2756457   | J05184616-2756457  | L0:           | ...   | L1.0              | 15.26 | 1.65      | 2009 Jan 25 | 120                     | 44; 44           |
| 2MASS J05264348-4455455   | J05264348-4455455  | M9.5          | ...   | M9.8              | 14.08 | 1.38      | 2013 Dec 12 | 120                     | 49; 49           |
| 2MASS J05301261+6253254   | J05301261+6253254  | L1            | ...   | L1.1              | 14.05 | 1.34      | 2008 Jan 09 | 120                     | 49; 49           |
| 2MASS J0534584-151143     | J0534584-151143    | M9            | ...   | M8.9              | 13.15 | 1.15      | 2013 Oct 29 | 120                     | 44; 44           |
| SDSSp J053951.99-005902.0 | J05395199-00590189 | L5            | L5    | L5.0              | 14.03 | 1.51      | 2009 Jan 24 | 120                     | 12; 12, 34       |
| 2MASS J05431887+6422528   | J05431887+6422528  | L1            | ...   | L1.2              | 13.57 | 1.52      | 2008 Jan 09 | 120                     | 49; 49           |
| 2MASS J05441150-2433010   | J05441150-2433010  | M8            | ...   | M7.6              | 12.53 | 1.07      | 2012 Dec 27 | 120                     | ... ; ...        |
| 2MASS J06022216+6336391   | J06022216+6336391  | L1:           | ...   | L1.5              | 14.27 | 1.58      | 2008 Jan 08 | 120                     | 49; 49           |
| LSR 0602+3910             | J06023045+3910592  | L1            | ...   | L0.8              | 12.30 | 1.44      | 2009 Nov 04 | 120                     | 88; 88           |
| 2MASS J06050190-2342260   | J06050190-2342260  | L0:           | ...   | M9.8              | 14.51 | 1.37      | 2012 Dec 27 | 120                     | 44; 44           |
| 2MASS J06050196-2342270   | J06050190-2342260  | L0:           | ...   | L1.1:             | 14.51 | 1.37      | 2009 Jan 25 | 120                     | 44; 44           |
| 2MASS J06085283-2753583   | J06085283-2753583  | M8.5 low g    | L0 lg | M9.6              | 3.600 | -8.78     | 2006 Sep 02 | 120                     | 27; 59, 71       |
| SIPS J0614-2019           | J06141196-2019181  | ...           | L4    | L1.3              | 14.78 | 1.41      | 2006 Sep 01 | 120                     | ... ; 72         |
| DENIS-P J0615493-010041   | J06154934-01004158 | L2+/-1        | ...   | L1.0              | 13.75 | 1.21      | 2010 Jan 02 | 120                     | 53; 53           |

Table 2—Continued

| Source                   | Designation        | Spectral Type |     |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|--------------------------|--------------------|---------------|-----|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                          |                    | Opt           | NIR | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASS J06244595-4521548  | J06244595-45215479 | L5:           | ... | L5.1              | 14.48 | 1.88      | 2012 Dec 27 | 120                     | 53; 53           |
| SDSS J062621.22+002934.2 | J06262121+00293410 | L1            | ... | L0.3              | 15.93 | 1.07      | 2013 Oct 29 | 120                     | 49; 49           |
| 2MASS J06411840-4322329  | J06411839-43223290 | L1.5          | ... | L2.4:             | 13.75 | 1.30      | 2010 Jan 02 | 120                     | 20; 20           |
| DENIS-P J0652197-253450  | J06521977-25345058 | L0            | ... | M9.2              | 12.76 | 1.24      | 2012 Dec 27 | 120                     | 49; 49           |
|                          |                    |               |     |                   |       |           | 2009 Jan 25 | 120                     | 53; 53           |
|                          |                    |               |     |                   |       |           | 2009 Nov 04 | 120                     | 53; 53           |
| DENIS-P J0652197-253450  | J06521977-2534505  | L0            | ... | M9.2              | 12.76 | 1.24      | 2006 Sep 02 | 120                     | 53; 53           |
| LEHPM 2-461              | J06591011-4747002  | M6.5          | M7  | M7.4              | 13.64 | 0.92      | 2006 Dec 20 | 120                     | 32; 87, 75       |
| LEHPM 2-436              | J07075333-4900574  | M8.5          | M8  | M8.8              | 13.23 | 1.12      | 2006 Dec 20 | 120                     | 32; 75           |
|                          |                    |               |     |                   |       |           | 2006 Dec 21 | 120                     | 32; 37, 75       |
| 2MASSW J0708213+295035   | J07082132+29503500 | L5            | ... | L5.4:             | 16.72 | 1.95      | 2013 Dec 12 | 120                     | 13; 13           |
| DENIS-P J0716478-063037  | J07164790-06303696 | L1+/-1        | ... | L1.1              | 13.90 | 1.33      | 2010 Jan 02 | 120                     | 53; 53           |
|                          |                    |               |     |                   |       |           | 2011 Apr 04 | 120                     | 53; 53           |
| 2MASS J07200325-0846499  | J07200325-0846499  | M9:           | ... | M9.8              | 10.63 | 1.16      | 2013 Dec 05 | 120                     | 70; 70           |
| 2MASS J07231462+5727081  | J07231462+5727081  | L1            | ... | L0.2              | 13.97 | 1.36      | 2008 Jan 08 | 120                     | 49; 49           |
| SDSS J07342570+30065792  | J07342571+3006583  | M8            | ... | M7.6              | 15.13 | 1.05      | 2009 Jan 25 | 120                     | 48; 48           |
| SDSS J07351959+4108503   | J07351959+4108503  | L0            | ... | M8.9              | 15.78 | 0.93      | 2010 Jan 26 | 120                     | 60; 60           |
|                          |                    |               |     |                   |       |           | 2011 Mar 09 | 120                     | 60; 60           |
| 2MASSW J0740096+321203   | J07400965+32120320 | L4.5          | ... | L4.0              | 16.19 | 1.97      | 2010 Jan 26 | 120                     | 61; 61           |
|                          |                    |               |     |                   |       |           | 2012 Dec 27 | 120                     | 13; 13           |
| SDSS J074756.31+394732.9 | J07475631+3947329  | L0            | ... | M8.3              | 15.08 | 1.35      | 2008 Jan 11 | 120                     | 20; 20           |
| SDSS J074838.61+174332.9 | J07483861+1743329  | L7            | ... | L6.0              | 16.27 | 1.85      | 2013 Oct 29 | 120                     | 54; 54           |
| DENIS-P J0751164-253043  | J07511645-2530432  | L2.5          | ... | L1.1              | 13.16 | 1.17      | 2009 Nov 04 | 120                     | 53; 53           |
| 2MASSI J0753321+291711   | J07533216+29171190 | L2            | ... | L2.0              | 15.52 | 1.67      | 2010 Jan 28 | 120                     | 13; 13           |
|                          |                    |               |     |                   |       |           | 2011 Apr 03 | 120                     | 13; 13           |
| 2MASS J07575274+0914103  | J07575274+0914103  | L4.:          | ... | L3.7:             | 15.86 | 1.77      | 2013 Apr 26 | 120                     | 54; 54           |
| SDSS J080048.13+465825.5 | J08004815+46582560 | L2            | ... | L1.3              | 15.51 | 1.20      | 2011 Mar 09 | 75                      | 20; 20           |
| 2MASS J08041429+0330474  | J08041429+0330474  | M8.5          | ... | M9.7              | 13.69 | 1.25      | 2013 Oct 29 | 120                     | 49; 49           |
| SDSS J080959.01+443422.2 | J08095903+4434216  | ...           | L6  | L6.3:             | 16.44 | 2.02      | 2008 Jan 12 | 120                     | 34; 40           |
| DENIS-P J0812316-244442  | J08123170-24444239 | L2.5+/-1      | ... | L0.9              | 13.82 | 1.43      | 2010 Jan 03 | 120                     | 53; 53           |
|                          |                    |               |     |                   |       |           | 2012 Dec 27 | 120                     | 53; 53           |
| SDSS J08175749+1824050   | J08175749+1824050  | L1            | ... | L2.0              | 15.09 | 1.27      | 2013 Apr 26 | 120                     | 60; 60           |
| SDSS J08181228+3310482   | J08181228+3310482  | L0            | ... | L1.3              | 15.99 | 0.93      | 2011 Apr 03 | 120                     | 60; 60           |
| SDSS J081946.02+165853.9 | J08194602+1658539  | M9            | ... | M8.6              | 13.79 | 1.17      | 2013 Dec 05 | 120                     | 74; 74           |
| DENIS J0823031-491201    | J08230313-4912012  | L1.5          | L3  | L2.7              | 13.55 | 1.48      | 2013 Nov 24 | 120                     | 53; 53, 68       |
| 2MASS J08230838+6125208  | J08230837+61252079 | L2:           | ... | L2.5              | 14.82 | 1.62      | 2011 Apr 03 | 120                     | 49; 49           |
| SDSS J08264265+19392195  | J08264262+1939224  | L0            | ... | M9.2              | 14.78 | 1.20      | 2010 Jan 25 | 120                     | 48; 48           |
| 2MASSW J0829066+145622   | J08290664+1456225  | L2            | ... | L1.0              | 14.75 | 1.58      | 2008 Jan 08 | 120                     | 13; 13           |
| GJ 1111                  | J08294949+2646348  | M6.5          | ... | M7.2              | 8.230 | 0.97      | 2013 Dec 12 | 120                     | 2; 58            |
| 2MASSW J0829570+265510   | J08295706+26550990 | L6.5          | ... | L6.4.:            | 17.11 | 2.15      | 2013 Dec 12 | 120                     | 13; 13           |



Table 2—Continued

| Source                    | Designation        | Spectral Type |     |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|-----|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASS J08303256+0947150   | J08303256+0947150  | M8            | ... | M7.8              | 11.89 | 1.13      | 2012 Dec 27 | 120                     | ... ; ...        |
| 2MASS J08315564+1025466   | J08315564+1025466  | M9            | ... | M8.6              | 13.62 | 1.17      | 2009 Mar 21 | 120                     | ... ; 49         |
| 2MASSW J0832045-012835    | J08320451-0128360  | L1.5          | ... | L1.2              | 14.13 | 1.42      | 2008 Jan 10 | 120                     | 13; 13           |
| 2MASS J08352366+1029318   | J08352366+1029318  | M7            | ... | M7.9              | 13.14 | 1.09      | 2013 Dec 05 | 120                     | 49; 49           |
| SDSS J08354533+2224308    | J08354537+2224310  | L0            | ... | M8.7              | 15.74 | 1.29      | 2010 Jan 25 | 120                     | 60; 60           |
| 2MASS J08355829+0548308   | J08355829+05483080 | L3            | ... | L1.7              | 14.53 | 1.36      | 2010 Jan 24 | 120                     | 49; 55           |
|                           |                    |               |     |                   |       |           | 2011 Apr 04 | 120                     | 49; 55           |
| SDSS J08362199+4949315    | J08362199+4949315  | L0            | ... | M9.3:             | 15.42 | 0.88      | 2011 Mar 09 | 120                     | 60; 60           |
| SDSS J08364634+0526426    | J08364635+0526426  | L0            | ... | M9.4              | 14.58 | 1.29      | 2008 Sep 23 | 120                     | 60; 60           |
| 2MASS J08391608+1253543   | J08391608+1253543  | M9            | ... | M8.8              | 13.75 | 1.16      | 2013 Dec 12 | 120                     | 74; 74           |
| LHS 2034                  | J08402975+1824091  | M6            | ... | M7.0              | 11.05 | 1.01      | 2013 Dec 12 | 120                     | 1; 57            |
| SDSS J08410685+6035063    | J08410685+6035063  | L4            | ... | L1.5              | 15.94 | 1.25      | 2011 Apr 03 | 120                     | 60; 60           |
| SDSS J08430794+3141292    | J08430794+3141292  | L3            | ... | L2.5              | 15.99 | 1.34      | 2011 Apr 03 | 120                     | 60; 60           |
| SDSS J08433328+1024435    | J08433328+1024435  | L1            | ... | L2.7:             | 14.87 | 1.20      | 2013 Dec 12 | 120                     | 60; 60           |
| SDSS J084403.46+043436.19 | J08440346+04343619 | M8            | ... | M8.7              | 13.46 | 1.05      | 2013 Dec 12 | 120                     | 48; 48           |
| SDSS J08475148+0138110    | J08475148+0138110  | L3            | ... | L3.2              | 16.23 | 1.82      | 2013 Dec 05 | 120                     | 60; 60           |
| 2MASS J08490052+0220155   | J08490052+0220155  | M8            | ... | M7.3              | 12.93 | 1.03      | 2013 Dec 05 | 120                     | 74; 74           |
| 2MASS J08533434-0329432   | J08533434-0329432  | M9e           | ... | M8.6              | 15.04 | 0.52      | 2009 Mar 21 | 120                     | ... ; ...        |
| SDSS J08583697+2710508    | J08583697+2710508  | L0            | ... | L0.0              | 15.05 | 1.39      | 2011 Mar 09 | 120                     | 60; 60           |
| 2MASSI J0859254-194926    | J08592522-1949279  | L6::          | L8  | L6.8              | 15.53 | 1.78      | 2008 Jan 12 | 120                     | 27; 27, 69       |
| 2MASS J08593854+6341355   | J08593854+6341355  | L0            | ... | M8.6              | 13.70 | 1.31      | 2008 Jan 11 | 120                     | 49; 49           |
| 2MASS J08594029+1145325   | J08594029+1145325  | M8            | ... | M8.4              | 12.74 | 1.25      | 2012 Dec 27 | 120                     | ... ; ...        |
| LHS 2090                  | J09002359+2150054  | M6.5          | ... | M7.3              | 9.440 | 1.00      | 2013 Dec 12 | 120                     | 17; 58           |
| SDSS J09002368+2539343    | J09002368+2539343  | L7            | ... | L6.7              | 16.43 | 1.77      | 2013 Dec 12 | 120                     | 60; 60           |
| SDSS J090206.90+003319.36 | J09020690+00331936 | M7            | ... | M7.3              | 12.11 | 0.95      | 2013 Dec 05 | 120                     | 48; 48           |
| SDSS J09094813+1940439    | J09094813+1940439  | L1            | ... | M9.9              | 14.73 | 1.29      | 2013 Apr 26 | 120                     | 60; 60           |
| DENIS-P J0909-0658        | J09095749-0658186  | L0            | ... | L0.2              | 13.89 | 1.35      | 2008 Jan 10 | 120                     | 9; 52            |
| 2MASS J09161504+2139512   | J09161504+2139512  | M9            | ... | M9.8              | 13.22 | 1.15      | 2013 Dec 12 | 120                     | 74; 74           |
| 2MASSW J0918382+213406    | J09183814+21340580 | L2.5          | ... | L2.7              | 15.66 | 1.76      | 2011 Apr 03 | 120                     | 11; 11           |
| SDSS J09230870+2340137    | J09230870+2340137  | L1            | ... | L2.3              | 13.85 | 1.04      | 2011 Mar 09 | 120                     | 60; 60           |
| 2MASSW J0928397-160312    | J09283972-1603128  | L2            | ... | L1.7              | 15.32 | 1.71      | 2008 Jan 12 | 120                     | 13; 13           |
| SDSS J09311323+2802271    | J09311323+2802271  | L3            | ... | L2.5:             | 14.98 | 1.25      | 2011 Mar 09 | 120                     | 60; 60           |
| SDSS J093128.22+052821.93 | J09312822+05282193 | M7            | ... | M8.4              | 12.86 | 1.06      | 2013 Dec 05 | 120                     | 48; 48           |
| SDSS J09323747+6725145    | J09323747+6725145  | L0            | ... | M9.4              | 15.91 | 0.92      | 2011 Apr 03 | 120                     | 60; 60           |
| 2MASS J09340617+0536234   | J09340617+0536234  | M8 pec        | ... | M7.5              | 15.57 | 0.81      | 2004 Mar 11 | 120                     | 45; 45, 75       |
| 2MASS J09352803-2934596   | J09352802-29345959 | L0            | ... | L0.3              | 14.04 | 1.21      | 2012 Dec 27 | 120                     | 49; 49           |
| SDSS J09385888+0443439    | J09385888+0443439  | L0            | ... | M7.8              | 15.24 | 1.24      | 2013 Apr 26 | 120                     | 60; 60           |
| SDSS J09404788+2946530    | J09404788+2946530  | L1            | ... | L0.4              | 15.29 | 1.37      | 2013 Apr 26 | 120                     | 60; 60           |
| SDSS J09413492+1009421    | J09413492+1009421  | L0            | ... | M8.7              | 14.58 | 1.21      | 2013 Apr 26 | 120                     | 60; 60           |
| 2MASSW J0944027+313132    | J09440279+3131328  | L2            | ... | L1.7              | 15.50 | 1.49      | 2008 Jan 09 | 120                     | 13; 13           |

Table 2—Continued

| Source                    | Designation        | Spectral Type |            |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|------------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR        | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASS 09474477+0224327    | J09474477+0224327  | M8:           | ...        | M8.2              | 13.17 | 1.09      | 2013 Dec 05 | 120                     | 49; 49           |
| LHS 2195                  | J09492223+0806450  | M8.5          | ...        | M8.5              | 12.31 | 1.10      | 2013 Dec 12 | 120                     | 49; 49           |
| 2MASS J09524622+0620410   | J09524622+0620410  | M8            | ...        | M7.3              | 12.45 | 0.99      | 2013 Dec 12 | 120                     | 74; 74           |
| 2MASS J09532126-1014205   | J09532126-1014205  | L0            | ...        | M9.4              | 13.47 | 1.33      | 2008 Jan 12 | 120                     | 44; 44           |
| 2MASS J09532126-1014205   | J09532126-10142056 | L0            | ...        | L0.0              | 13.47 | 1.33      | 2006 Dec 20 | 120                     | 44; 44           |
| NLTT 22851B               | J09532455+0526583  | M9.5          | ...        | M9.8              | 15.67 | 1.28      | 2013 Dec 05 | 120                     | 62; 62           |
| SDSS J100319.17-010508.15 | J10031917-01050815 | M7            | ...        | M8.0              | 12.33 | 1.09      | 2013 Dec 12 | 120                     | 48; 48           |
| G 196-3B                  | J10042066+5022596  | L3beta        | ...        | L5.6::            | 14.83 | 2.05      | 2006 Dec 23 | 120                     | 7; 56            |
| LHS 5166B                 | J10043929-33351889 | L4            | ...        | L4.5:             | 14.48 | 1.56      | 2013 Apr 26 | 120                     | 22; 22           |
| LHS 2243                  | J10163470+2751497  | M8 V          | ...        | M7.4              | 11.99 | 1.03      | 2013 Dec 12 | 120                     | 5; 5             |
| 2MASS J1017075+130839     | J10170754+1308398  | L2:           | L1         | L1.1              | 14.10 | 1.39      | 2008 Jan 12 | 120                     | 27; 27, 30       |
| SDSS J10174251+4310579    | J10174251+4310579  | L1            | ...        | L0.9              | 15.55 | 1.03      | 2011 Mar 09 | 120                     | 60; 60           |
| 2MASSW J1018588-290953    | J10185879-29095349 | L1            | ...        | L0.3              | 14.21 | 1.42      | 2012 Dec 27 | 120                     | 22; 22           |
| DENIS J1019245-270717     | J10192447-2707171  | L0.5          | ...        | M9.1              | 13.53 | 1.06      | 2013 Dec 12 | 120                     | 59; 59           |
| 2MASS 10213232-2044069    | J10213232-2044069  | M9            | ...        | M8.5              | 13.19 | 1.13      | 2013 Dec 12 | 120                     | 49; 49           |
| 2MASS J10220489+0200477   | J10220489+0200477  | L0            | ...        | M9.0              | 14.10 | 1.20      | 2008 Jan 10 | 120                     | 49; 49           |
| 2MASS J10224821+5825453   | J10224821+5825453  | L1beta        | ...        | L0.6              | 13.50 | 1.34      | 2008 Jan 11 | 120                     | 49; 49           |
| SDSS J102552.43+321234.0  | J10255227+3212349  | ...           | L7.5+/-2.5 | L5.8:             | 15.91 | 0.84      | 2008 Jan 08 | 120                     | 40; 40           |
| 2MASS J1029216+162652     | J10292165+1626526  | L2.5          | ...        | L2.8              | 14.29 | 1.67      | 2008 Jan 12 | 120                     | 13; 13           |
| SDSS J10330910+1216259    | J10330910+1216259  | L0            | ...        | M8.9              | 15.07 | 1.12      | 2013 Apr 26 | 120                     | 60; 60           |
| SDSS J10340567+0350163    | J10340567+0350163  | L0            | ...        | M8.7              | 14.70 | 1.07      | 2013 Apr 26 | 120                     | 60; 60           |
| 2MASSW J1035245+250745    | J10352455+2507450  | L1            | ...        | L1.1              | 14.76 | 1.47      | 2008 Jan 08 | 120                     | 13; 13           |
| DENIS J104617.0-421237    | J10461703-4212372  | ...           | M8         | M8.2              | 14.29 | 1.01      | 2008 Jan 24 | 120                     | ... ; 84         |
| LP 213-68                 | J10471381+4026493  | M8            | ...        | M8.2              | 12.44 | 1.18      | 2013 Dec 12 | 120                     | 16; 16           |
| DENIS-P J1047-1815        | J10473108-18155739 | L2.5          | ...        | L0.3              | 14.20 | 1.31      | 2012 Dec 27 | 120                     | 10; 10           |
| SDSS J104922.45+012559.2  | J10492244+01255930 | L5            | ...        | L3.5:             | 15.88 | 1.77      | 2011 Apr 04 | 120                     | 54; 54           |
| 2MASS J10511900+5613086   | J10511900+56130860 | L2            | ...        | L0.8              | 13.24 | 1.34      | 2012 May 30 | 75                      | 49; 49           |
| SDSS J10515124+13111633   | J10515124+13111633 | L0            | ...        | M9.5:             | 14.83 | 1.20      | 2013 Apr 26 | 120                     | 48; 48           |
| SDSS J105547.29+080842.64 | J10554729+08084264 | M9            | ...        | M8.5              | 12.55 | 1.18      | 2013 Dec 12 | 120                     | 48; 48           |
| 2MASS J1059513-211308     | J10595138-21130819 | L1            | ...        | L2.8:             | 14.56 | 1.35      | 2012 Dec 27 | 120                     | 27; 27           |
| LHS 2351                  | J11061897+0428327  | M7            | ...        | M7.6              | 12.33 | 1.00      | 2013 Dec 12 | 120                     | 4; 39            |
| 2MASS J11073750-2759385B  | J11073750-2759385  | ...           | M7         | M7.0              | ...   | ...       | 2009 Dec 29 | 120                     | ... ; 84         |
| Gliese 417BC              | J11122567+35481310 | L4.5          | ...        | L4.8              | 14.58 | 1.86      | 2007 Mar 16 | 120                     | 13; 13           |
| LHS 2397a                 | J11214909-1313082  | M8            | ...        | M8.5              | ...   | ...       | 2011 Mar 09 | 120                     | ... ; ...        |
| 2MASSW J1122362-391605    | J11223623-39160540 | L3            | ...        | L3.7::            | 15.71 | 1.83      | 2012 Dec 27 | 120                     | 22; 22           |
| SDSS J11264703+5816322    | J11264703+5816322  | L3            | ...        | L1.3              | 15.84 | 1.30      | 2011 Apr 03 | 120                     | 60; 60           |
| LEHPM 2-333               | J11414421-2232204  | ...           | M8         | M8.8              | 12.63 | 1.06      | 2006 Apr 09 | 120                     | 32; 75           |
| SDSS J11491231-0153006    | J11491231-0153006  | L1            | ...        | M8.5              | 14.67 | 0.96      | 2011 Mar 09 | 120                     | 60; 60           |
| 2MASS J11533966+5032092   | J11533966+5032092  | L1:           | ...        | L0.3              | 14.19 | 1.34      | 2008 Jan 11 | 120                     | 49; 49           |
| GJ 3693                   | J11535267+0659561  | M8            | ...        | M7.0              | 11.26 | 0.99      | 2013 Dec 12 | 120                     | 4; 63            |

Table 2—Continued

| Source                    | Designation        | Spectral Type |               |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|---------------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR           | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASS J11544223-3400390   | J11544223-3400390  | L0            | ...           | L0.5              | 14.20 | 1.34      | 2008 Jan 09 | 120                     | 38; 52           |
| 2MASSW J11553951-3727349  | J11553951-37273499 | L2            | ...           | L2.3              | 12.81 | 1.35      | 2012 Dec 27 | 120                     | 22; 22           |
| LP 851-346                | J11554286-2224586  | M7.5          | ...           | M7.7              | 10.93 | 1.05      | 2013 Dec 12 | 120                     | 24; 24           |
| DENIS-P J1157480-484442   | J11574809-48444283 | L0.5+/-1      | ...           | M9.4              | 14.01 | 1.21      | 2008 Jan 24 | 120                     | 53; 53           |
| DENIS-P J1159+0057        | J11593850+00572679 | L0            | ...           | L0.4              | 14.08 | 1.27      | 2013 Apr 25 | 120                     | 10; 20           |
| SDSS J11594072+5409386    | J11594072+5409386  | L2            | ...           | L0.9              | 15.22 | 1.46      | 2013 Apr 24 | 120                     | 60; 60           |
| SDSSp J120358.19+001550.3 | J12035811+00155000 | L3            | ...           | L5.0              | 14.01 | 1.53      | 2011 Apr 04 | 120                     | 12; 12           |
| 2MASSI J1204303+321259    | J12043036+32125950 | L0            | M9            | M9.6              | 13.82 | 1.30      | 2013 Apr 24 | 120                     | 27; 27, 30       |
| SDSS J12061049+6242572    | J12061049+6242572  | L1            | ...           | L2.1              | 15.65 | 1.70      | 2011 Mar 09 | 120                     | 60; 60           |
| DENIS J1206501-393725     | J12065011-3937261  | L2            | ...           | L1.9              | 14.32 | 1.22      | 2007 Mar 17 | 120                     | 59; 59           |
| 2MASS J12073804-3909050   | J12073803-39090500 | L2:           | ...           | L0.9              | 14.69 | 1.44      | 2011 Mar 11 | 120                     | 49; 49           |
| 2MASSI J1213033-043243    | J12130335-04324369 | L5            | ...           | L4.2              | 14.68 | 1.67      | 2011 Apr 04 | 120                     | 27; 27           |
| BRI 1222-1222             | J12245222-1238352  | M9            | ...           | M8.5              | 12.57 | 1.22      | 2006 Jun 01 | 120                     | 89; ...          |
| 2MASS J12312141+4959234   | J12312141+49592339 | L2            | ...           | L3.4              | 14.62 | 1.48      | 2013 Apr 24 | 120                     | 44; 44           |
| 2MASS J12321827-0951502   | J12321827-0951502  | L0            | ...           | M9.5              | 13.73 | 1.17      | 2008 Jan 14 | 120                     | 49; 49           |
| SDSS J12455566+4902109    | J12455566+4902109  | L1            | ...           | M7.8:             | 15.95 | 0.75      | 2011 Mar 09 | 120                     | 60; 60           |
| 2MASSW J1246467+402715    | J12464677+40271500 | L4            | ...           | L4.0              | 15.09 | 1.81      | 2011 Apr 03 | 120                     | 13; 13           |
| SDSS J125128.43+624310.7  | J12512843+6243107  | L4            | ...           | L4.2              | 15.49 | 1.13      | 2013 Apr 24 | 120                     | 54; 54           |
| 2MASS J12565688+0146163   | J12565688+0146163  | L2:           | ...           | L1.6              | 14.48 | 1.69      | 2009 Jun 30 | 120                     | 49; 49           |
| SDSSp J125737.26-011336.1 | J12573726-0113360  | L4            | L5            | L5.8              | 15.94 | 1.82      | 2009 Jun 30 | 120                     | 21; 20, 34       |
| 2MASSW J1300425+191235    | J13004255+1912354  | L1            | L3            | L1.7              | 12.72 | 1.09      | 2006 Apr 10 | 120                     | 14; 14, 50       |
| 2MASS J13015465-1510223   | J13015464-15102229 | L1            | ...           | L0.5              | 14.54 | 1.44      | 2013 Apr 26 | 120                     | 49; 49           |
| GJ 499C                   | J13054106+2046394  | L4:           | ...           | L6.5              | 15.20 | 1.83      | 2009 Jun 30 | 120                     | 27; 27           |
| 2MASS J13061727+3820296   | J13061726+38202960 | L0            | ...           | L0.6              | 14.63 | 1.41      | 2011 Apr 03 | 120                     | 49; 49           |
| SDSS J131142.1+362923.9   | J13114192+3629247  | L6            | L5 pec (blue) | L6.8              | 15.55 | 1.40      | 2012 Jul 09 | 120                     | 54; 54, 66       |
| 2MASS J13120700+3937440   | J13120700+3937440  | L0:           | ...           | M8.8              | 14.14 | 1.25      | 2012 May 30 | 75                      | ... ; ...        |
| 2MASSI J1315309-264951    | J13153094-2649513  | L5.5          | ...           | L6.7              | 15.20 | 1.73      | 2009 Jun 30 | 120                     | 79; 52           |
| 2MASS J13204427+0409045   | J13204427+04090450 | L3::          | ...           | L2.5              | 15.25 | 1.63      | 2013 Apr 24 | 120                     | 49; 49           |
| DENIS-P J1323-1806        | J13233597-18063790 | L0            | ...           | L0.0              | 14.90 | 1.24      | 2013 Apr 26 | 120                     | 10; 10           |
| 2MASSW J1326201-272937    | J13262009-2729370  | L5            | ...           | L6.6:             | 15.85 | 1.99      | 2009 Jun 30 | 120                     | 22; 22           |
| SDSS J13271521+0759375    | J13271521+0759375  | L1            | ...           | L0.5              | 14.60 | 1.36      | 2013 Apr 25 | 120                     | 60; 60           |
| 2MASSW J1328550+211449    | J13285503+2114486  | L5            | ...           | L4.1              | 16.19 | 1.93      | 2009 Jun 30 | 120                     | 11; 11           |
| SDSS J133148.92-011651.4  | J13314893-01165000 | L6            | L8+/-2.5      | L6.1              | 15.46 | 1.39      | 2011 Mar 09 | 120                     | 20; 20, 34       |
| SDSS J13331279+1509566    | J13331279+1509566  | L0            | ...           | M7.8              | 15.84 | 0.75      | 2011 Mar 11 | 120                     | 60; 60           |
| SDSS J13334536-0216002    | J13334536-0216002  | L3            | ...           | L2.2              | 15.38 | 1.53      | 2013 Apr 25 | 120                     | 60; 60           |
| 2MASS J13364062+3743230   | J13364062+3743230  | L1            | ...           | L0.4              | 14.41 | 1.31      | 2013 Apr 26 | 120                     | 44; 44           |
| 2MASS J13373116+4938367   | J13373115+49383670 | L0            | ...           | M8.9              | 13.77 | 1.19      | 2012 May 30 | 75                      | 44; 44           |
| 2MASSW J1338261+414034    | J13382614+41403420 | L2.5          | ...           | L2.4              | 14.22 | 1.45      | 2012 May 30 | 75                      | 13; 13           |
| 2MASS J13384944+0437315   | J13384944+04373150 | L1            | ...           | L0.0              | 14.16 | 1.42      | 2012 May 30 | 75                      | 49; 49           |
| 2MASS J13411160-3052505   | J13411160-30525049 | L2::          | ...           | L2.7:             | 14.61 | 1.53      | 2012 Jul 09 | 120                     | 49; 49           |

Table 2—Continued

| Source                      | Designation        | Spectral Type |          |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|-----------------------------|--------------------|---------------|----------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                             |                    | Opt           | NIR      | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASSW J1343167+394508      | J13431670+39450870 | L5            | ...      | L5.3::            | 16.16 | 2.01      | 2013 Apr 24 | 120                     | 13; 13           |
| SDSS J13571490-1438520      | J13571490-1438520  | M7            | ...      | M8.5              | 12.85 | 1.11      | 2012 May 30 | 75                      | ... ; ...        |
| 2MASS J13595510-4034582     | J13595510-40345819 | L1            | ...      | L3.1:             | 13.65 | 1.08      | 2013 Apr 25 | 120                     | 49; 49           |
| 2MASS J14022235+0648479     | J14022235+0648479  | M9            | ...      | M8.9              | 13.72 | 1.21      | 2010 Jul 07 | 120                     | ... ; ...        |
| 2MASS J14044495+4634297     | J14044495+4634297  | L0:           | ...      | M9.7              | 14.34 | 1.28      | 2008 Jul 13 | 120                     | 44; 44           |
| SDSS J14060148+5249309      | J14060148+5249309  | L0            | ...      | M9.8              | 15.56 | 1.00      | 2011 Mar 09 | 120                     | ... ; 60         |
| 2MASS J14090310-3357565     | J14090310-3357565  | L2            | ...      | L1.3              | 14.25 | 1.38      | 2010 Jul 07 | 120                     | 52; 52           |
| 2MASSW J1411175+393636      | J14111735+3936363  | L1.5          | ...      | L1.5              | 14.64 | 1.40      | 2008 Jul 13 | 120                     | 13; 13           |
| 2MASS J14122270+2354100     | J14122270+2354100  | M9            | ...      | M7.8              | 13.73 | 1.08      | 2009 Jun 30 | 120                     | ... ; ...        |
| 2MASSW J1412244+163312      | J14122449+1633115  | L0.5          | ...      | M9.9              | 13.89 | 1.37      | 2008 Jul 30 | 120                     | 13; 13           |
| SDSS J14205830+2131566      | J14205830+2131566  | L1            | ...      | L0.0:             | 15.12 | 1.06      | 2011 Mar 11 | 120                     | 60; 60           |
| 2MASSW J1421314+182740      | J14213145+1827407  | L0            | ...      | M8.9              | 13.23 | 1.29      | 2008 Jul 30 | 120                     | 14; 49           |
| SDSS J142227.25+221557.1    | J14222720+2215575  | ...           | L6.5+/-2 | L5.4:             | 17.06 | 1.42      | 2009 Jun 30 | 120                     | 40; 40           |
| SDSS J14225715+0827521      | J14225715+0827521  | L2            | ...      | L2.1              | 15.10 | 1.45      | 2013 Apr 25 | 120                     | 60; 60           |
| 2MASS J14232186+6154005     | J14232186+6154005  | ...           | L4       | L4.5              | 16.60 | 1.32      | 2013 Apr 26 | 120                     | 65; 65           |
| GD 165B                     | J14243909+0917104  | L4            | L3+/-2   | L4.4              | 15.69 | 1.52      | 2009 Jun 29 | 120                     | 3; 11, 34        |
| DENIS-P J142527.97-365023.4 | J14252798-3650229  | L3:           | L5       | L4.5::            | 13.75 | 1.94      | 2010 Jul 07 | 120                     | 31; 49, 31       |
| 2MASS J14261286+3130394     | J14261286+3130394  | L4            | ...      | L4.0::            | 16.62 | 1.90      | 2013 Apr 25 | 120                     | 54; 54           |
| 2MASS J14283132+5923354     | J14283132+59233546 | L4            | ...      | L4.4              | 14.78 | 1.52      | 2012 Jul 09 | 120                     | 49; 49           |
| LHS 2924                    | J14284313+3310368  | M9 V          | ...      | M9.1              | 11.99 | 1.25      | 2007 Jul 04 | 120                     | ... ; ...        |
| 2MASSI J1430435+291540      | J14304358+2915405  | L2            | L0.5     | L1.5              | 14.27 | 1.50      | 2008 Jul 13 | 120                     | 30; 27, 30       |
| SDSS J14324210+3451427      | J14324210+3451427  | L1            | ...      | L1.2              | 15.75 | 0.98      | 2011 Apr 19 | 120                     | 60; 60           |
| SDSS J14380829+64083631     | J14380829+64083631 | L0            | ...      | L0.2              | 12.98 | 1.33      | 2011 Mar 11 | 120                     | 48; 48           |
| SDSS J143832.63+572216.9    | J14383259+5722168  | L5            | ...      | L4.6              | 15.96 | 1.59      | 2010 Jul 07 | 120                     | 54; 54           |
| 2MASSW J1438549-130910      | J14385498-13091029 | L3:           | ...      | L3.1              | 15.49 | 1.63      | 2012 Jul 09 | 120                     | 13; 13           |
| SDSS J143933.44+031759.2    | J14393342+03175909 | L1            | ...      | L0.7              | 15.99 | 1.18      | 2011 Apr 19 | 120                     | 20; 20           |
| SDSS J14403025+12333391     | J14403025+12333391 | M9            | ...      | M8.6              | 14.41 | 1.22      | 2013 Mar 27 | 75                      | 48; 48           |
| 2MASSI J1441045+271932      | J14410457+27193234 | M7            | ...      | M7.0              | 12.99 | 1.02      | 2013 Mar 27 | 75                      | 44; 44           |
| G 124-62BC                  | J14413716-09455900 | L0.5          | ...      | L0.4              | 14.02 | 1.36      | 2008 Jul 14 | 120                     | 10; 13           |
|                             |                    |               |          |                   |       |           | 2011 Mar 09 | 120                     | 10; 13           |
| G 239-25 B                  | J14422175+6603198  | ...           | L0+/-1   | M8.1              | 11.51 | 1.18      | 2010 Jul 07 | 120                     | 35; 78           |
| SSSPM 1444-2019             | J14442067-2019222  | d/sdM9        | d/sdM7   | M9.0              | 12.55 | 0.61      | 2005 Mar 23 | 120                     | 33; 45, 75       |
| 2MASS J14442946+0048530     | J14442946+0048530  | M9            | ...      | M8.1              | 15.95 | 0.76      | 2009 Jun 30 | 120                     | ... ; ...        |
| SDSSp J144600.60+002452.0   | J14460060+00245190 | L6            | L5       | L4.2              | 15.89 | 1.96      | 2011 Mar 11 | 120                     | 21; 20, 34       |
| 2MASSW J1449378+235537      | J14493784+2355378  | L0            | ...      | M9.5              | 15.82 | 1.51      | 2008 Jul 13 | 120                     | 13; 13           |
| 2MASS J14520183+1114590     | J14520183+1114590  | L2            | ...      | L2.9              | 15.52 | 1.18      | 2013 Apr 26 | 120                     | 77; 62           |
| SDSS J14525558+2723244      | J14525558+2723244  | L0            | ...      | L0.2:             | 14.92 | 0.84      | 2011 Mar 09 | 120                     | 60; 60           |
| SDSS J14532589+1420418      | J14532589+1420418  | L1            | ...      | L4.1:             | 15.07 | 1.18      | 2013 Apr 26 | 120                     | 60; 60           |
| LEHPM 2-50                  | J14560172-2747288  | ...           | L1       | M9.3              | 13.25 | 1.06      | 2006 Mar 12 | 120                     | 32; 75           |
| LHS 3003                    | J1456383-280947    | M7            | ...      | M7.7              | 9.970 | 1.04      | 2008 Jul 29 | 120                     | ... ; ...        |

Table 2—Continued

| Source                      | Designation        | Spectral Type |          |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|-----------------------------|--------------------|---------------|----------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                             |                    | Opt           | NIR      | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| LEHPM 2-498                 | J14565736-2631265  | ...           | M8       | M7.7              | 13.56 | 0.95      | 2006 Mar 12 | 120                     | 32; 75           |
| PSS 1458+2839               | J1458245+283958    | M8.5          | ...      | M8.5              | 13.08 | 1.23      | 2008 Jul 13 | 120                     | ... ; ...        |
| 2MASS J15004572+4219448     | J15004572+4219448  | M9            | ...      | M8.4              | 13.77 | 1.13      | 2012 May 30 | 75                      | ... ; ...        |
| TVLM 513-46546              | J1501081+225002    | M8.5          | ...      | M9.3              | 11.87 | 1.16      | 2008 Jul 30 | 120                     | ... ; ...        |
| 2MASS J15101685-024107      | J15101685-024107   | M9            | ...      | M9.3              | 12.61 | 1.27      | 2009 Jun 29 | 120                     | ... ; ...        |
| SDSS J15102955+36194699     | J15102955+36194699 | M9            | ...      | M8.3              | 14.00 | 1.18      | 2013 Aug 14 | 120                     | 48; 48           |
| 2MASS J15111091+4340363     | J15111091+4340363  | L5            | ...      | L5.8              | 16.60 | 1.90      | 2013 Apr 25 | 120                     | 54; 54           |
| SDSS J15124067+3403501      | J15124067+3403501  | L3            | ...      | L0.7              | 15.04 | 1.63      | 2013 Apr 25 | 120                     | 60; 60           |
| 2MASS J15230657-2347526     | J15230657-2347526  | ...           | L2.5     | L0.3              | 14.20 | 1.30      | 2008 Jul 29 | 120                     | 47; 82           |
| SDSS J153453.33+121949.2    | J15345324+12194950 | ...           | L4+/-1.5 | L5.5              | 15.33 | 1.51      | 2012 Jul 09 | 120                     | 40; 40           |
| 2MASS J15345700-1418480     | J15345700-1418480  | M7            | ...      | M8.6              | 11.39 | 1.08      | 2012 May 30 | 75                      | ... ; ...        |
| DENIS-P J153941.96-052042.4 | J15394189-0520428  | L4:           | L2       | L4.2              | 13.92 | 1.35      | 2008 Jul 14 | 120                     | 31; 52, 31       |
| LEHPM 2-287                 | J15453990-2255167  | ...           | M8       | M8.2              | 13.71 | 1.09      | 2006 Apr 09 | 120                     | 32; 75           |
| 2MASS J15474719-2423493     | J15474719-2423493  | M9            | ...      | M9.0              | 13.97 | 1.23      | 2008 Jul 29 | 120                     | 49; 49           |
| SDSS J154849.02+172235.4    | J15484911+17223590 | ...           | L5       | L6.6              | 16.10 | 1.65      | 2013 Aug 14 | 120                     | 40; 40           |
| 2MASS J15485834-1636018     | J15485834-1636018  | ...           | L2+/-1   | M8.8              | 13.89 | 1.26      | 2010 Jul 07 | 120                     | 47; 47           |
| SDSS J15512086+4329303      | J15512086+4329303  | L3            | ...      | L3.1              | 15.13 | 1.50      | 2011 Apr 19 | 120                     | 60; 60           |
| SDSS J15525232-0035019      | J15525232-0035019  | L0            | ...      | M9.6:             | 15.99 | 0.98      | 2011 Apr 19 | 120                     | 60; 60           |
| 2MASSW J1552591+294849      | J15525906+2948485  | L0beta        | L1       | L0.5:             | 13.48 | 1.46      | 2008 Jul 30 | 120                     | 30; 56, 30       |
| 2MASSW J1553214+2109071     | J15532142+2109071  | L5.5          | ...      | L6.6:             | 16.70 | 2.02      | 2009 Jun 29 | 120                     | 11; 11           |
| 2MASSW J1555157-095605      | J15551573-0956055  | L1            | ...      | L1.6              | 12.56 | 1.11      | 2008 Jul 14 | 120                     | 22; 22           |
| SDSS J15564435+1723089      | J15564435+1723089  | L0            | ...      | L0.7              | 14.67 | 1.32      | 2013 Aug 14 | 120                     | 60; 60           |
| 2MASS J15573270+1752380     | J15573270+1752380  | M7.5          | ...      | M8.3              | 13.54 | 1.09      | 2013 Aug 14 | 120                     | 44; 44           |
| 2MASSI J1600054+170832      | J16000548+1708328  | L1.5          | ...      | L1.8              | 16.05 | 1.37      | 2008 Jul 12 | 120                     | 13; 13           |
| 2MASS J16082460+195747      | J16082460+195747   | M9            | ...      | M8.6              | 13.52 | 1.17      | 2009 Jun 29 | 120                     | ... ; ...        |
| LSR 1610-0040               | J16102900-0040530  | sdL:          | d/sdM6   | M7.0:             | 12.91 | 0.89      | 2004 Mar 12 | 120                     | 26; 26, 42       |
| 2MASS J16134550+1708270     | J16134550+1708270  | M9.5          | ...      | M9.6              | 13.47 | 1.28      | 2009 Jun 29 | 120                     | ... ; ...        |
| 2MASSW J1615441+355900      | J16154416+3559005  | L3            | ...      | L3.6              | 14.54 | 1.60      | 2009 Jun 30 | 120                     | 13; 13           |
| 2MASS J16184503-1321297     | J16184503-1321297  | L0:           | ...      | M9.3              | 14.25 | 1.33      | 2010 Jul 07 | 120                     | 52; 52           |
| SDSS J161928.31+005011.9    | J16192830+0050118  | L2            | ...      | L1.3              | 14.39 | 1.20      | 2008 Jul 30 | 120                     | 20; 20           |
| LEHPM 2-1973                | J16202207-2446025  | ...           | M7       | M7.0              | 14.32 | 0.94      | 2006 Apr 09 | 120                     | 32; 75           |
| GJ 618.1B                   | J16202614-0416315  | L2.5          | ...      | L2.4              | 15.28 | 1.69      | 2008 Jul 30 | 120                     | 18; 18           |
| 2MASS J16203450-2430200     | J16203456-2430205  | M6.5          | ...      | M9.4:             | 14.20 | 1.66      | 2008 Jul 29 | 120                     | ... ; ...        |
| 2MASS J16210822+2938480     | J16210822+2938480  | M9            | ...      | M9.4              | 15.17 | 0.84      | 2009 Jun 30 | 120                     | ... ; ...        |
| SDSS J16260303+2113130      | J16260303+2113130  | L3            | ...      | L4.7:             | 15.48 | 1.56      | 2013 Apr 24 | 120                     | 60; 60           |
| 2MASS J16301770-2120010     | J16301770-2120010  | ...           | M9:      | M9.4              | 14.51 | 1.32      | 2008 Jul 29 | 120                     | 77; ...          |
|                             |                    |               |          |                   |       |           | 2008 Aug 28 | 120                     | 77; ...          |
| 2MASS J16304139+0938446     | J16304138+09384459 | L0::          | ...      | L0.4:             | 14.87 | 1.57      | 2011 Apr 19 | 120                     | 49; 49           |
| SDSS J16311227+32271141     | J16311227+32271141 | M7            | ...      | M8.2              | 13.15 | 0.91      | 2013 Apr 26 | 120                     | 48; 48           |
| SDSS J163256.1+350507.3     | J1632561+3505073   | L1            | ...      | L0.7              | 14.65 | 1.35      | 2012 Jul 09 | 120                     | 74; 74           |

Table 2—Continued

| Source                    | Designation        | Spectral Type |          |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|----------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR      | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| SDSS J16351918+42230531   | J16351918+42230531 | M8            | ...      | M8.6              | 12.88 | 1.09      | 2013 Apr 26 | 120                     | 48; 48           |
| SDSSp J163600.79-003452.6 | J16360078-0034525  | L0            | ...      | M9.0              | 14.59 | 1.18      | 2008 Jul 30 | 120                     | 12; 12           |
| 2MASS J16452207+3004071   | J16452207+3004071  | L3            | ...      | L2.3              | 15.19 | 1.60      | 2008 Jul 13 | 120                     | 44; 44           |
| 2MASS J16452207+3004071   | J16452207+30040718 | L3            | ...      | L3.0              | 15.19 | 1.60      | 2012 Jul 09 | 120                     | 44; 44           |
| 2MASS J16490419+0444571   | J16490419+0444571  | M8            | ...      | M8.1              | 12.96 | 1.08      | 2013 Aug 14 | 120                     | 49; 49           |
| SDSS J16545079+3747146    | J16545079+3747146  | L2            | ...      | L0.7              | 15.01 | 1.35      | 2013 Apr 26 | 120                     | 60; 60           |
| VB 8                      | J16553529-0823401  | M7 V          | ...      | M7.0              | 9.780 | 0.96      | 2007 Jul 04 | 120                     | ... ; ...        |
| 2MASS J16573454+1054233   | J16573454+1054233  | L2            | ...      | L1.4              | 14.15 | 1.35      | 2009 Jun 29 | 120                     | 49; 49           |
| WISE J165842.56+510335.0  | J16584256+5103350  | ...           | L6pec    | L5.5:             | 15.06 | 1.40      | 2013 Oct 23 | 120                     | 69; 69           |
| SDSS J16585026+1820006    | J16585026+1820006  | L0            | ...      | L0.9              | 15.48 | 0.91      | 2010 Jul 07 | 120                     | ... ; ...        |
| SDSS J17031670+19063603   | J17031670+19063603 | L0            | ...      | M8.9              | 14.92 | 1.27      | 2012 Jul 09 | 120                     | 48; 48           |
| 2MASS J17072343-0558249B  | J17072343-05582489 | ...           | L3       | L0.0              | 12.26 | 1.23      | 2006 Aug 28 | 120                     | 41; 41           |
| DENIS J1707252-013809     | J17072529-0138093  | L0.5          | L2       | L1.0              | 14.29 | 1.22      | 2006 Aug 28 | 120                     | 59; 59, 64       |
| 2MASSI J1707333+430130    | J17073334+4301304  | L0.5          | ...      | M8.7              | 13.97 | 1.35      | 2008 Sep 08 | 120                     | 27; 27           |
| SDSS J17104934+33232518   | J17104934+33232518 | L0            | ...      | M9.4              | 15.13 | 1.05      | 2011 Apr 19 | 120                     | 48; 48           |
| 2MASS J17111353+2326333   | J17111353+2326333  | L0:           | ...      | L0.5:             | 14.50 | 1.44      | 2008 Jul 13 | 120                     | 44; 44           |
| G 203-50 B                | J17114530+4029021  | ...           | L5+2-1.5 | L5.0              | 15.00 | 1.20      | 2008 Sep 09 | 120                     | 86; 86           |
|                           |                    |               |          |                   |       |           | 2010 Jul 07 | 120                     | 86; 86           |
| 2MASS J10511900+5613086   | J17170450+1509530  | M7            | ...      | M7.9              | 13.61 | 1.11      | 2012 May 30 | 75                      | ... ; ...        |
| SDSS J171714.10+652622.2  | J17171408+6526221  | L4            | ...      | L6.2              | 14.95 | 1.77      | 2009 Jun 30 | 120                     | 20; 20           |
| SDSS J17175402+64274503   | J17175402+64274503 | M8            | ...      | M8.8              | 14.41 | 1.03      | 2013 Oct 22 | 120                     | 48; 48           |
| 2MASSI J1721039+334415    | J17210390+3344160  | L3            | L5+/-1   | L5.3:             | 13.63 | 1.14      | 2008 Sep 08 | 120                     | 27; 27, 50       |
| SDSS J172244.32+632946.8  | J17224432+6329470  | L0            | ...      | L0.7              | 15.37 | 1.29      | 2009 Jun 30 | 120                     | 20; 20           |
| SDSS J17254384+5325349    | J17254384+5325349  | L1            | ...      | M8.0              | 15.16 | 0.95      | 2010 Jul 07 | 120                     | ... ; ...        |
| 2MASSI J1726000+153819    | J17260007+1538190  | L3beta        | ...      | L3.6::            | 15.67 | 2.01      | 2008 May 11 | 120                     | 13; 56           |
|                           |                    |               |          |                   |       |           | 2008 Jul 13 | 120                     | 13; 56           |
| 2MASS J17281134+0839590   | J17281134+0839590  | M9 pec        | ...      | M9.8              | 13.63 | 1.13      | 2009 Jun 29 | 120                     | ... ; ...        |
| DENIS-P J1733423-165449   | J17334227-1654500  | L0.5+/-1      | ...      | L0.9              | 13.53 | 1.18      | 2006 Apr 11 | 120                     | 53; 53           |
| 2MASSW J1743415+212707    | J17434148+2127069  | L2.5          | ...      | L2.4              | 15.83 | 1.51      | 2009 Jun 30 | 120                     | 13; 13           |
| DENIS-P J1745346-164053   | J17453466-1640538  | L1.5+/-1      | ...      | L1.3              | 13.65 | 1.24      | 2008 Sep 08 | 120                     | 53; 53           |
| 2MASS J17461199+5034036   | J17461199+50340362 | L5            | ...      | L5.7              | 15.10 | 1.57      | 2012 Jul 09 | 120                     | 49; 49           |
| 2MASS J18000116-1559235   | J18000116-1559235  | L5.5          | ...      | L4.3              | 13.30 | ...       | 2012 Jul 09 | 120                     | 68; 68           |
| 2MASS J18064570+2923591   | J18064570+2923591  | M8:           | ...      | M8.3              | 14.20 | 1.26      | 2010 Jul 07 | 120                     | ... ; ...        |
| LSR 1826+3014             | J18261131+3014201  | M8.5          | d/sdM8.5 | M9.9              | 11.66 | 0.85      | 2004 Sep 09 | 120                     | 23; 23, 75       |
| SDSS J183929.17+442438    | J18392917+442438   | M9            | ...      | M8.9              | 13.43 | 1.08      | 2008 Nov 04 | 120                     | 48; 48           |
| DENIS J19013910-3700170   | J19013910-3700170  | M8            | ...      | L0.1::            | 14.26 | 1.96      | 2013 Apr 24 | 120                     | 59; 59           |
| DENIS-P J1909081-193748   | J19090821-1937479  | L1+/-1        | ...      | L1.4              | 14.52 | 1.61      | 2008 Sep 08 | 120                     | 53; 53           |
| VB 10                     | J19165762+0509021  | M8 V          | ...      | M8.0              | 9.910 | 1.14      | 2007 Jul 04 | 120                     | 90; 73           |
| 2MASS J19233810-3308410   | J19233810-3308410  | M7            | ...      | M8.5              | 13.27 | 1.04      | 2012 Sep 27 | 120                     | ... ; ...        |
| DENIS JJ1934511-184134    | J1934511-184134    | M8.5          | ...      | M8.5              | 14.28 | 1.15      | 2013 Oct 23 | 120                     | 59; 59           |

Table 2—Continued

| Source                   | Designation        | Spectral Type |          |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|--------------------------|--------------------|---------------|----------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                          |                    | Opt           | NIR      | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| LEHPM 2-90               | J19453495-2557190  | ...           | M9       | M8.9              | 12.35 | 0.84      | 2006 Sep 02 | 120                     | 32; 75           |
| 2MASS J19561542-1754252  | J19561542-1754252  | M8            | L0+/-1   | M8.5              | 13.75 | 1.10      | 2007 Sep 16 | 120                     | 47; 49, 82       |
| 2MASS J20025073-0521524  | J20025073-05215242 | L6            | ...      | L6.8::            | 15.32 | 1.90      | 2007 Jul 04 | 120                     | 44; 44           |
| DENIS J2013108-124244    | J2013108-124244    | L1.5          | ...      | L0.7              | 14.52 | 1.21      | 2013 Oct 22 | 120                     | 59; 59           |
| 2MASS J20263647+0439400  | J20263647+0439400  | M9:           | ...      | M8.5              | 14.16 | 1.23      | 2009 Jun 28 | 120                     | ... ; ...        |
| 2MASS J2035203-311008    | J2035203-311008    | M7            | ...      | M7.9              | 13.19 | 1.03      | 2010 Jul 07 | 120                     | ... ; ...        |
| 2MASS J20414283-3506442  | J20414283-3506442  | L2:           | ...      | L1.9              | 14.89 | 1.49      | 2008 Sep 08 | 120                     | 44; 44           |
| SDSS J204724.7+142152    | J2047247+142152    | M7.5          | ...      | M8.9              | 13.04 | 1.16      | 2008 Nov 03 | 120                     | 48; 48           |
| LEHPM 2-381              | J20522811-4758362  | M8            | M8       | M8.1              | 12.94 | 1.06      | 2004 Sep 06 | 120                     | 32; 75           |
| 2MASSI J2054358+151904   | J20543585+1519043  | L1:           | ...      | L0.3              | 16.37 | 1.39      | 2009 Jun 28 | 120                     | 13; 13           |
| 2MASSI J2057153+171515   | J20571538+1715154  | L1.5          | ...      | M9.9              | 15.97 | 1.47      | 2009 Jun 28 | 120                     | 13; 13           |
| 2MASS J20575592-0050060  | J20575592-0050060  | M9            | ...      | M9.3              | 14.97 | 1.20      | 2009 Jun 29 | 120                     | ... ; ...        |
| 2MASS J21075409-4544064  | J21075409-45440639 | L0:           | ...      | L2.6              | 14.92 | 1.53      | 2013 Aug 14 | 120                     | 49; 49           |
| HB 2115-4518             | J2118317-450552    | M8.5          | ...      | M8.6              | 13.43 | 1.06      | 2008 Jul 14 | 120                     | ... ; ...        |
| SDSS J211846.77-001044.6 | J21184677-00104469 | L1            | ...      | L2.2:             | 16.20 | 1.13      | 2012 Sep 27 | 120                     | 54; 54           |
| SDSS J212033.89+102159   | J21203389+102159   | M8            | ...      | M9.0              | 13.54 | 1.12      | 2008 Nov 03 | 120                     | 48; 48           |
| 2MASS J21233110-2345180  | J21233110-2345180  | M7.5          | ...      | M8.2              | 13.58 | 1.04      | 2013 Jul 17 | 75                      | 44; 44           |
| 2MASS J21263403-3143220  | J21263403-3143220  | M9            | ...      | M9.2              | 13.47 | 1.10      | 2009 Jun 28 | 120                     | ... ; ...        |
| HB 2124-4228             | J2127261-421518    | M7.5          | ...      | M8.9              | 13.32 | 1.14      | 2008 Jul 14 | 120                     | ... ; ...        |
| HB 2126-4459             | J2130086-444627    | M8.5          | ...      | M8.2              | 14.32 | 1.15      | 2008 Jul 14 | 120                     | ... ; ...        |
| 2MASSW J2130446-084520   | J21304463-08452049 | L1.5          | ...      | M8.3              | 14.14 | 1.32      | 2006 Sep 01 | 120                     | 52; 52           |
|                          |                    |               |          |                   |       |           | 2006 Sep 02 | 120                     | 52; 52           |
|                          |                    |               |          |                   |       |           | 2008 Jul 13 | 120                     | 52; 52           |
|                          |                    |               |          |                   |       |           | 2008 Sep 09 | 120                     | 52; 52           |
|                          |                    |               |          |                   |       |           | 2012 Sep 27 | 120                     | 52; 52           |
|                          |                    |               |          |                   |       |           | 2012 Oct 27 | 120                     | 52; 52           |
| SDSS J213240.36+102949.4 | J21324035+10294940 | ...           | L4.5+/-1 | L4.8::            | 16.59 | 1.96      | 2012 Oct 27 | 120                     | 40; 40           |
| SDSS J213307.94+232159   | J21330794+232159   | M9.5          | ...      | M9.6              | 13.74 | 1.18      | 2008 Nov 04 | 120                     | 48; 48           |
| SDSS J213435.61+240408   | J21343561+240408   | M8            | ...      | M9.2              | 13.57 | 1.17      | 2008 Nov 04 | 120                     | 48; 48           |
| 2MASS J21371044+1450475  | J21371044+1450475  | L2            | ...      | L0.8              | 14.13 | 1.32      | 2008 Sep 08 | 120                     | 49; 49           |
| DENIS J21391360-3529500  | J21391360-3529500  | L0            | ...      | L2.1:             | 14.47 | 1.11      | 2013 Aug 14 | 120                     | 59; 59           |
| SDSS J214046.55+011259.7 | J21404654+0112594  | L3            | ...      | L4.4              | 15.89 | 1.47      | 2008 Sep 08 | 120                     | 20; 20           |
| 2MASS J21420580-3101162  | J21420580-3101162  | L3            | ...      | L2.9              | 15.84 | 1.88      | 2010 Jul 07 | 120                     | 43; 43           |
| SDSS J214527.82-073434.2 | J21452782-0734342  | M9            | ...      | M8.7              | 15.59 | 1.28      | 2009 Nov 04 | 120                     | 48; 48           |
| 2MASS J21472764+0101040  | J21472764+0101040  | M9            | ...      | M9.1              | 14.57 | 1.10      | 2009 Jun 28 | 120                     | ... ; ...        |
| 2MASS J21481628+4003593  | J21481633+4003594  | L6            | L6.5pec  | L4.0              | 14.15 | 2.38      | 2005 Sep 09 | 120                     | 51; 51           |
| 2MASS J21483083+0020540  | J21483083+0020540  | M9            | ...      | M8.5              | 15.46 | 1.15      | 2009 Jun 28 | 120                     | ... ; ...        |
| SDSS J214956.55+060334   | J21495655+060334   | M9            | ...      | M8.1              | 13.34 | 1.17      | 2008 Nov 03 | 120                     | 48; 48           |
| SDSS J215339.77+295005   | J21533977+295005   | M9            | ...      | M8.8              | 13.94 | 1.17      | 2008 Nov 03 | 120                     | 48; 48           |
| 2MASS J21580457-1550098  | J21580456-15500980 | L4:           | ...      | L4.3:             | 15.04 | 1.85      | 2006 Sep 01 | 120                     | 52; 52           |



Table 2—Continued

| Source                    | Designation        | Spectral Type |        |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|---------------------------|--------------------|---------------|--------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                           |                    | Opt           | NIR    | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| 2MASS J22044198-0036510   | J22044198-0036510  | M9            | ...    | M8.5              | 15.73 | 1.24      | 2009 Jun 29 | 120                     | ... ; ...        |
| 2MASSW J2206450-421721    | J22064498-4217208  | L2            | ...    | L4.2::            | 15.56 | 1.95      | 2008 Jul 14 | 120                     | 13; 13           |
| GRH 2208-2007             | J2210499-195224    | M7.5          | ...    | M8.8              | 14.00 | 0.85      | 2008 Jul 14 | 120                     | ... ; ...        |
| 2MASS J22114470+6856262   | J22114470+6856262  | ...           | L2     | L2.2              | 15.67 | 1.65      | 2005 Sep 08 | 120                     | 61; 61           |
| 2MASS J22134491-2136079   | J22134491-21360789 | L0gamma       | ...    | L1.9:             | 15.38 | 1.62      | 2006 Sep 02 | 120                     | 44; 56           |
|                           |                    |               |        |                   |       |           | 2008 Aug 29 | 120                     | 44; 56           |
| WISE J222219.93+302601.4  | J22221993+3026014  | ...           | L9     | L6.7:             | 16.55 | 1.37      | 2013 Oct 23 | 120                     | 69; 69           |
| LHS 523                   | J22285440-1325178  | M6.5          | ...    | M7.7              | 10.77 | 0.92      | 2007 Sep 16 | 120                     | ... ; ...        |
| 2MASP J2234330+291850     | J2234331+291849    | M8:           | ...    | M7.9              | 14.04 | 1.08      | 2008 Jul 12 | 120                     | ... ; ...        |
| 2MASS J22355013+1227370   | J22355013+1227370  | M9            | ...    | M9.2              | 15.21 | 1.17      | 2009 Jun 30 | 120                     | ... ; ...        |
| 2MASSI J2238074+435317    | J22380742+4353179  | L1.5          | ...    | L0.6              | 13.84 | 1.32      | 2009 Nov 07 | 120                     | 27; 27           |
|                           |                    |               |        |                   |       |           | 2010 Jul 07 | 120                     | 27; 27           |
| SDSS J22434553-08215302   | J22434553-08215302 | M8            | ...    | M8.4              | 15.43 | 1.14      | 2013 Jul 17 | 75                      | 48; 48           |
| SDSS J225003.72+143046.7  | J22500372+1430467  | M9            | ...    | M8.7              | 14.94 | 1.22      | 2009 Nov 04 | 120                     | 48; 48           |
|                           |                    |               |        |                   |       |           | 2009 Nov 07 | 120                     | 48; 48           |
| 2MASSI J2254519-284025    | J22545194-2840253  | L0.5          | L0.5   | L0.2              | 14.13 | 1.18      | 2008 Jul 14 | 120                     | 27; 27, 31       |
| SDSSp J225529.09-003433.4 | J22552907-0034336  | L0:           | ...    | M8.6              | 15.65 | 1.21      | 2008 Sep 07 | 120                     | 19; 19           |
| ULAS J22585405+0113512    | J22585405+0113512  | M9            | ...    | M8.8              | 13.91 | 1.00      | 2013 Aug 14 | 120                     | 62; 62           |
| SDSS J225913.88-005158.2  | J22591388-0051581  | L2            | ...    | L1.6              | 16.36 | 1.71      | 2009 Jun 29 | 120                     | 20; 20           |
| SDSS J230809.9-313122     | J2308099-313122    | M7            | ...    | M7.5              | 13.62 | 1.04      | 2008 Nov 04 | 120                     | 48; 48           |
| DENIS J2308113-272200     | J2308113-272200    | L1.5          | ...    | L1.4              | 14.58 | 1.40      | 2013 Sep 03 | 120                     | 59; 59           |
| SSSPM J2310-1759          | J23101846-1759090  | L0:           | L1     | M9.9              | 14.38 | 1.41      | 2008 Jul 14 | 120                     | 83; 44, 37       |
| SDSS J23172515-00543358   | J23172515-00543358 | M9            | ...    | M8.7              | 15.68 | 0.94      | 2012 Sep 27 | 120                     | 48; 48           |
| 2MASS J2320292+412341     | J2320292+412341    | L1:           | ...    | M9.8              | 14.59 | 1.39      | 2003 Aug 12 | 75                      | 76; ...          |
|                           |                    |               |        |                   |       |           | 2008 Sep 08 | 120                     | ... ; ...        |
| 2MASS J23211254-1326282   | J23211254-1326282  | ...           | L1     | L0.4              | 14.50 | 1.36      | 2003 Sep 04 | 75                      | 47; 47           |
|                           |                    |               |        |                   |       |           | 2008 Jul 12 | 120                     | 47; 47           |
|                           |                    |               |        |                   |       |           | 2008 Sep 08 | 120                     | 47; 47           |
| SDSS J232136.11-002819.1  | J23213611-0028191  | M9            | ...    | M8.3              | 15.48 | 1.04      | 2009 Nov 04 | 120                     | 48; 48           |
| SDSS J232246.84-313323    | J23224684-313323   | L0:           | ...    | L1.6:             | 13.58 | 1.25      | 2006 Aug 28 | 120                     | 48; 48           |
|                           |                    |               |        |                   |       |           | 2008 Nov 04 | 120                     | 48; 48           |
| SDSS J232313.4-024435     | J2323134-024435    | M8.5          | ...    | M8.0              | 13.58 | 1.10      | 2008 Nov 03 | 120                     | 48; 48           |
| 2MASS J23302258-0347189   | J23302258-0347189  | L1:           | ...    | L0.5              | 14.48 | 1.35      | 2008 Jul 14 | 120                     | 44; 44           |
| HD 221356BC               | J23310217-0406248  | M9+L3         | ...    | M8.7              | 12.94 | 0.98      | 2013 Dec 05 | 120                     | 14; 46           |
| LSPM J2331+4607N          | J23311807+4607310  | ...           | d/sdM7 | M7.4              | 15.92 | 0.74      | 2005 Sep 07 | 120                     | ... ; 75         |
| 2MASS J23312935+1552220   | J23312935+1552220  | L0            | ...    | M9.5              | 15.06 | 1.06      | 2009 Jun 30 | 120                     | ... ; ...        |
| SDSS J233224.38-005025    | J23322438-005025   | M8            | ...    | M7.7              | 13.65 | 1.04      | 2008 Nov 03 | 120                     | 48; 48           |
| SDSS J233350.76-000011.3  | J23335076-0000113  | M9            | ...    | M8.6              | 15.52 | 0.98      | 2009 Nov 07 | 120                     | 48; 48           |
| 2MASS J23335838+0050110   | J23335838+0050110  | M9            | ...    | M9.3              | 15.01 | 1.17      | 2009 Jul 01 | 120                     | ... ; ...        |
| SDSS J23352642+0817213    | J23352642+0817213  | L0            | ...    | M9.5              | 14.72 | 1.34      | 2012 Oct 24 | 120                     | 60; 60           |

Table 2—Continued

| Source                  | Designation        | Spectral Type |      |                   | 2MASS |           | Date        | $\lambda/\Delta\lambda$ | Ref <sup>b</sup> |
|-------------------------|--------------------|---------------|------|-------------------|-------|-----------|-------------|-------------------------|------------------|
|                         |                    | Opt           | NIR  | SpeX <sup>a</sup> | $J$   | $J - K_s$ |             |                         |                  |
| SDSS J23371664-09332480 | J23371664-09332480 | M8            | ...  | M7.6              | 13.41 | 1.13      | 2013 Aug 14 | 120                     | 48; 48           |
| 2MASS J2341286-113335   | J2341286-113335    | M8            | ...  | M7.9              | 13.55 | 1.00      | 2010 Jul 07 | 120                     | ... ; ...        |
| 2MASS J23440624-0733282 | J23440624-0733282  | L4.5          | ...  | L6.0              | 14.80 | 1.57      | 2009 Jun 29 | 120                     | 52; 52           |
| 2MASS J23453903+0055137 | J23453903+0055137  | M9            | ...  | M9.2              | 13.77 | 1.19      | 2008 Jul 14 | 120                     | 49; 49           |
| SDSS J234654.7-315353   | J2346547-315353    | M8            | ...  | M8.7              | 13.28 | 1.08      | 2008 Nov 04 | 120                     | 48; 48           |
| 2MASS J2352050-110043   | J2352050-110043    | M7            | ...  | M8.0              | 12.84 | 1.10      | 2010 Jul 07 | 120                     | ... ; ...        |
| DENIS-P J2353-0833      | J2353594-083331    | M8.5          | ...  | M8.6              | 13.03 | 1.10      | 2010 Jul 07 | 120                     | ... ; ...        |
| DENIS J23545990-1852210 | J23545990-1852210  | L2            | ...  | L2.6:             | 14.22 | 1.39      | 2013 Aug 14 | 120                     | 59; 59           |
| SSSPM J2356-3426        | J23561081-3426044  | M9.0          | L0.5 | M9.3              | 12.95 | 0.98      | 2007 Sep 16 | 120                     | 37; 37           |
| SSSPM J2400-2008        | J23595762-2007394  | M9.5          | L1   | M8.9              | 14.38 | 1.13      | 2008 Jul 14 | 120                     | 37; 37           |

<sup>a</sup>Near-infrared classification from SpeX data based on index method described in Burgasser (2007a).

<sup>b</sup>First citation is the discovery reference; next citation(s) are classification references (optical and near-infrared).

References. — (1) Haro & Chavira (1966); (2) Liebert (1976); (3) Becklin & Zuckerman (1988); (4) Bessell (1991); (5) Kirkpatrick et al. (1995); (6) Tinney et al. (1998); (7) Rebolo et al. (1998); (8) EROS Collaboration et al. (1999); (9) Delfosse et al. (1999); (10) Martín et al. (1999); (11) Kirkpatrick et al. (1999); (12) Fan et al. (2000); (13) Kirkpatrick et al. (2000); (14) Gizis et al. (2000b); (15) Basri et al. (2000); (16) Gizis et al. (2000a); (17) Scholz et al. (2001); (18) Wilson et al. (2001); (19) Schneider et al. (2002); (20) Hawley et al. (2002); (21) Geballe et al. (2002); (22) Gizis (2002); (23) Lépine et al. (2002); (24) Phan-Bao et al. (2003); (25) Kendall et al. (2003); (26) Lépine et al. (2003); (27) Cruz et al. (2003); (28) Cruz et al. (2003); (29) Berriman et al. (2003); (30) Wilson et al. (2003); (31) Kendall et al. (2004); (32) Pokorný et al. (2004); (33) Scholz et al. (2004); (34) Knapp et al. (2004); (35) Golimowski et al. (2004); (36) Deacon et al. (2005); (37) Lodieu et al. (2005); (38) Billères et al. (2005); (39) Reid & Gizis (2005); (40) Chiu et al. (2006); (41) McElwain & Burgasser (2006); (42) Cushing et al. (2006); (43) Liebert & Gizis (2006); (44) Cruz et al. (2007); (45) Burgasser et al. (2007a); (46) Caballero (2007); (47) Kendall et al. (2007); (48) West et al. (2008); (49) Reid et al. (2008); (50) Burgasser et al. (2008b); (51) Looper et al. (2008b); (52) Kirkpatrick et al. (2008); (53) Phan-Bao et al. (2008); (54) Zhang et al. (2009); (55) Faherty et al. (2009); (56) Cruz et al. (2009); (57) Shkolnik et al. (2009); (58) Jenkins et al. (2009); (59) Martín et al. (2010); (60) Schmidt et al. (2010); (61) Kirkpatrick et al. (2010); (62) Zhang et al. (2010); (63) Bochanski et al. (2011); (64) Phan-Bao (2011); (65) Geißler et al. (2011); (66) Kirkpatrick et al. (2011); (67) Shkolnik et al. (2012); (68) Folkes et al. (2012); (69) Thompson et al. (2013); (70) Scholz (2013); (71) Allers & Liu (2013); (72) Andrei et al. (2011); (73) Boeshaar & Tyson (1985); (74) Schmidt et al. (in prep); (75) This paper; (76) Cruz et al. (2013); (77) Deacon et al. (2009); (78) Forveille et al. (2004); (79) Hall (2002); (80) Irwin et al. (1991); (81) Kirkpatrick (priv. comm.); (82) Kendall et al. (2007); (83) Lodieu et al. (2002); (84) Looper et al. (in prep); (85) Phan-Bao (2011); (86) Radigan et al. (2008); (87) Ruiz & Takamiya (1995); (88) Salim et al. (2003); (89) Tinney et al. (1993); (90) van Biesbroeck (1961).

Table 3. Spectral indices\*

| Spectral Index         | Numerator Range ( $\mu\text{m}$ )  | Denominator Range ( $\mu\text{m}$ ) | Feature                                     | Ref. |
|------------------------|------------------------------------|-------------------------------------|---|------|
| $\text{H}_2\text{O}-J$ | 1.14-1.165                         | 1.26-1.285                          | 1.15 $\mu\text{m}$ $\text{H}_2\text{O}$     | 1    |
| $\text{CH}_4-J$        | 1.315-1.335                        | 1.26-1.285                          | 1.32 $\mu\text{m}$ $\text{CH}_4$            | 1    |
| $\text{H}_2\text{O}-H$ | 1.48-1.52                          | 1.56-1.60                           | 1.40 $\mu\text{m}$ $\text{H}_2\text{O}$     | 1    |
| $\text{CH}_4-H$        | 1.635-1.675                        | 1.56-1.60                           | 1.65 $\mu\text{m}$ $\text{CH}_4$            | 1    |
| $\text{H}_2\text{O}-K$ | 1.975-1.995                        | 2.08-2.10                           | 1.90 $\mu\text{m}$ $\text{H}_2\text{O}$     | 1    |
| $\text{CH}_4-K$        | 2.215-2.255                        | 2.08-2.12                           | 2.20 $\mu\text{m}$ $\text{CH}_4$            | 1    |
| $K/J$                  | 2.06-2.10                          | 1.25-1.29                           | $J - K$ color                               | 1    |
| $H$ -dip               | 1.61-1.64                          | 1.56-1.59 + 1.66-1.69 <sup>a</sup>  | 1.63 $\mu\text{m}$ $\text{FeH}/\text{CH}_4$ | 2    |
| $K$ -slope             | 2.06-2.10                          | 2.10-2.14                           | $K$ -band shape/CIA $\text{H}_2$            | 3    |
| $J$ -slope             | 1.27-1.30                          | 1.30-1.33                           | 1.28 $\mu\text{m}$ flux peak shape          | 4    |
| $J$ -curve             | 1.04-1.07 + 1.26-1.29 <sup>b</sup> | 1.14-1.17                           | Curvature across $J$ -band                  | 4    |
| $H$ -bump              | 1.54-1.57                          | 1.66-1.69                           | Slope across $H$ -band peak                 | 4    |
| $\text{H}_2\text{O}-Y$ | 1.04-1.07                          | 1.14-1.17                           | 1.15 $\mu\text{m}$ $\text{H}_2\text{O}$     | 4    |

\*Indices were calculated by integrating flux between the specified wavelength ranges.

<sup>a</sup>Denominator is average of these two wavelength ranges.

<sup>b</sup>Numerator is average of these two wavelength ranges.

References. — (1) Burgasser et al. (2006a); (2) Burgasser et al. (2010a); (3) Burgasser et al. (2002); (4) This paper.

Table 4. Delimiters for selection regions in parameter spaces.

| x vs. y   | Limits   |
|---|--|
| SpT vs. CH <sub>4</sub> -H                        | Best fit curve: $y = -4.3 \times 10^{-4}x^2 + 0.0253x + 0.7178$ , $\sigma = 0.0354$ .<br>Select points below the $-1\sigma$ curve.   |
| H <sub>2</sub> O- <i>J</i> vs. CH <sub>4</sub> -H | Intersection of: $y = -0.08x + 1.09$ and $x = 0.90$ .<br>Select points on lower left corner.   |
| H <sub>2</sub> O- <i>J</i> vs. <i>H</i> -bump     | Intersection of: $y = 0.16x + 0.806$ and $x = 0.90$ .<br>Select points on upper left corner.   |
| CH <sub>4</sub> - <i>J</i> vs. CH <sub>4</sub> -H | Intersection of: $y = -0.56x + 1.41$ and $y = 1.04$ .<br>Select points on lower left corner.   |
| CH <sub>4</sub> - <i>J</i> vs. <i>H</i> -bump     | Intersection of: $y = 1.00x + 0.24$ , $x = 0.74$ , and $y = 0.91$ .<br>Select points on upper left corner.   |
| CH <sub>4</sub> - <i>H</i> vs. <i>J</i> -slope    | Intersection of: $y = 1.250x - 0.207$ , $x = 1.03$ , and $y = 1.03$ .<br>Select points on upper left corner.   |
| CH <sub>4</sub> - <i>H</i> vs. <i>J</i> -curve    | Best fit curve: $y = 1.245x^2 - 1.565x + 2.224$ , $\sigma = 0.088$ .<br>Select points above the $1\sigma$ curve, up to CH <sub>4</sub> - <i>H</i> = 1.03.                    |
| CH <sub>4</sub> - <i>H</i> vs. <i>H</i> -bump     | Best fit curve: $y = 1.36x^2 - 4.26x + 3.89$ , $\sigma = 0.013$ .<br>Select points below the $-1\sigma$ curve, down to <i>H</i> -bump = 0.92.                                |
| <i>J</i> -slope vs. <i>H</i> -dip                 | Intersection of $y = 0.20x + 0.27$ and $x = 1.03$ .<br>Select points on lower right corner.  |
| <i>J</i> -slope vs. <i>H</i> -bump                | Intersection of: $y = -2.75x + 3.84$ and $y = 0.91$ .<br>Select points on upper right corner.  |
| <i>K</i> -slope vs. H <sub>2</sub> O- <i>Y</i>    | Best fit curve: $y = 12.036x^2 - 20.000x + 8.973$ , $\sigma = 0.064$ .<br>Select points above the $1\sigma$ curve and between <i>K</i> -slope = 0.93-0.96.                   |
| <i>J</i> -curve vs. <i>H</i> -bump                | Best fit curve: $y = 0.269x^2 - 1.326x + 2.479$ , $\sigma = 0.048$ .<br>Select points above the $1\sigma$ and greater than <i>J</i> -curve = 2.00 and <i>H</i> -bump = 0.92. |

Table 5. Binary candidates resulting from spectral fitting.

| Source                              | Primary SpT <sup>a</sup> | Secondary SpT <sup>a</sup> | Confidence <sup>b</sup> | $\Delta J$ | $\Delta K$ | SB Ref. | Comments <sup>c</sup> |
|-------------------------------------|--------------------------|----------------------------|-------------------------|------------|------------|---------|-----------------------|
| Strong Candidates                   |                          |                            |                         |            |            |         |                       |
| 2MASS J02361794+0048548             | L5.0±0.6                 | T1.9±1.1                   | 97%                     | 1.05±0.48  | 1.80±0.55  | 1       | ...                   |
| SDSS J093113.23+280227.1            | L1.4±0.1                 | T2.6±0.9                   | > 99%                   | 2.22±0.23  | 2.74±0.25  | 1       | V, B                  |
| 2MASS J13114227+3629235             | L4.8±0.6                 | T4.1±2.7                   | > 99%                   | 2.19±1.02  | 3.14±1.33  | 5       | V                     |
| 2MASS J13411160-30525049            | L1.2±0.3                 | T6.3±1.0                   | 98%                     | 3.28±0.53  | 4.82±0.63  | 1       | V                     |
| 2MASS J14532589+1420418             | L1.1±0.0                 | T6.0±1.1                   | > 99%                   | 3.27±0.46  | 4.42±0.63  | 1       | V, (B)                |
| 2MASS J20261584-2943124             | L0.1±0.5                 | T5.8±1.0                   | > 99%                   | 3.42±0.40  | 4.82±0.57  | 4       | V                     |
| Weak Candidates                     |                          |                            |                         |            |            |         |                       |
| 2MASS J02060879+22355930            | L5.1±0.5                 | T3.2±2.3                   | 95%                     | 1.61±0.89  | 2.36±1.25  | 1       | ...                   |
| DENIS-P J04272708-1127143           | M7.4±0.2                 | T5.1±1.5                   | 92%                     | 4.13±0.62  | 4.98±0.84  | 1       | ...                   |
| 2MASS J10365305-3441380             | L5.2±0.4                 | T1.4±0.4                   | > 99%                   | 0.51±0.32  | 1.41±0.24  | 1       | ...                   |
| 2MASS J10595138-2113082             | L0.6±0.4                 | T3.4±1.3                   | > 99%                   | 2.58±0.32  | 3.30±0.64  | 1       | V                     |
| SDSS J142227.20+221557.5            | L4.2±0.6                 | T4.1±2.3                   | 96%                     | 2.36±0.78  | 3.22±1.18  | 1       | B                     |
| WISE J16235970-0508114              | L0.6±0.3                 | T6.0±0.8                   | > 99%                   | 3.39±0.40  | 4.80±0.53  | 1       | ...                   |
| 2MASS J17072529-0138093             | L0.7±0.5                 | T4.3±2.0                   | 97%                     | 2.87±0.75  | 3.75±1.01  | 1       | ...                   |
| Visual Candidates                   |                          |                            |                         |            |            |         |                       |
| 2MASS J1711457+223204               | L1.5±0.6                 | T2.5±1.0                   | > 99%                   | 1.20±0.40  | 3.08±0.64  | 6       | V                     |
| Rejected Blue L dwarfs <sup>d</sup> |                          |                            |                         |            |            |         |                       |
| 2MASS J11181292-0856106             | L1.4±0.7                 | T2.3±2.3                   | 93%                     | 1.50±0.82  | 2.42±1.11  | ...     | B                     |
| SDSS J141624.09+134826.7            | L4.4±1.1                 | T3.9±1.4                   | > 99%                   | 2.12±0.42  | 2.99±0.67  | ...     | B                     |
| 2MASS J15150083+4847416             | L5.0±0.6                 | T2.7±1.9                   | 93%                     | 1.32±0.61  | 2.17±0.84  | 1       | B                     |
| 2MASS J17114559+4028578             | L4.4±0.3                 | T2.7±0.8                   | > 99%                   | 1.60±0.18  | 2.32±0.33  | ...     | B                     |
| Rejected Candidates                 |                          |                            |                         |            |            |         |                       |
| 2MASS J03205965+1854233             | M7.8±0.1                 | T6.0±1.5                   | 58%                     | 4.43±0.73  | 5.47±0.92  | ...     | V                     |
| 2MASS J03264453+1919309             | M8.5±0.0                 | T6.7±0.8                   | 87%                     | 4.66±0.50  | 5.91±0.58  | ...     | V                     |
| 2MASS J03303847-2348463             | M7.7±0.3                 | T5.6±1.6                   | 49%                     | 3.97±0.85  | 4.58±1.05  | ...     | ...                   |
| 2MASS J03301720+3505001             | M7.7±0.5                 | T5.3±1.7                   | 55%                     | 4.27±0.81  | 5.08±1.03  | ...     | ...                   |
| 2MASS J03440891+0111249             | L0.6±0.5                 | T4.8±2.1                   | 56%                     | 3.34±0.88  | 4.14±1.19  | ...     | ...                   |
| 2MASS J04024315+1730136             | M7.5±0.2                 | T5.4±1.7                   | 48%                     | 4.59±0.78  | 5.29±1.01  | ...     | ...                   |
| 2MASS J04430581-3202090             | L4.5±0.3                 | T1.7±1.0                   | 85%                     | 1.41±0.34  | 2.05±0.39  | 1       | B                     |
| 2MASS J08433328+1024435             | L0.9±0.3                 | T4.9±2.0                   | 80%                     | 3.01±0.75  | 3.99±1.03  | ...     | ...                   |
| 2MASS J08475148+0138110             | L2.0±0.7                 | T5.7±2.1                   | 59%                     | 3.19±0.74  | 4.61±1.07  | ...     | ...                   |
| 2MASS J14232186+6154005             | L1.9±0.8                 | T4.6±1.9                   | 72%                     | 2.63±0.67  | 3.78±0.97  | 3       | V                     |
| 2MASS J14493784+2355378             | M9.4±0.3                 | T6.2±1.7                   | 51%                     | 4.22±0.69  | 5.39±1.00  | 2       | V                     |
| 2MASS J15412408+5425598             | M7.6±0.3                 | T5.4±1.6                   | 55%                     | 4.53±0.75  | 5.22±0.99  | ...     | ...                   |
| 2MASS J16403561+2922225             | M8.1±0.7                 | T5.3±1.7                   | 51%                     | 4.38±0.77  | 5.09±1.00  | ...     | ...                   |
| 2MASS J17175402+64274503            | M8.5±0.1                 | T4.6±1.8                   | 86%                     | 4.18±0.70  | 4.93±1.02  | ...     | ...                   |
| 2MASS J19064847+4011068             | L0.0±0.4                 | T5.9±1.8                   | 74%                     | 3.68±0.75  | 4.85±1.01  | ...     | ...                   |
| 2MASS J20472471+1421526             | M8.4±0.2                 | T5.7±1.6                   | 81%                     | 4.10±0.70  | 5.13±0.95  | ...     | V                     |
| 2MASS J23311807+4607310             | M7.5±0.0                 | T5.7±1.5                   | 53%                     | 4.60±0.75  | 5.30±0.95  | ...     | ...                   |

<sup>a</sup>Uncertainties include systematics from spectral classification of Burgasser (2007a).

<sup>b</sup>Confidence that the source fits the binary template better than the single template based on a one-sided F-test. See Section 3.3.

<sup>c</sup>B = Unusually blue L dwarf, (B) = From this paper; V = Also a visual candidate.

<sup>d</sup>See Section 5.1.

References. — (1) This paper; (2) Bouy et al. (2003); (3) Geißler et al. (2011); (4) Gelino & Burgasser (2010); (5) Kirkpatrick et al. (2011); (6) Burgasser et al. (2010a).